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A New Electric Dairy Utensil Sterilizer

By H. Elmer Besley[1]

STERILIZATION of dairy utensils is now a common practice on dairy farms selling whole milk or cream. It is required on those farms from which milk products are sent to the principal cities. The types of sterilizers most commonly used on these farms at present are steam, hot water, and chemical.

With the advance of rural electrification, a need has been felt for an electric sterilizer with low connected load and power consumption so that it might be profitably used where power charges are based on connected load and with metered rates. Work on such a sterilizer was undertaken by the National Rural Electric Project and the agricultural engineering department of the University of Maryland in cooperation with the dairy department of the same institution. A modified steam-electric sterilizer was finally produced which has the following outstanding features:

1. It does a consistently better job of sterilizing than most other equipment. It is not dependent on the human element for uniformly good results day after day.
2. It leave utensils dry, minimizing rusting and further growth of bacteria.
3. It is reasonable in operating cost.
4. No attention is necessary after loading in the equipment and turning on the switch. Labor, dirt, and fire hazard are greatly reduced.

This sterilizer is a completely insulated box heated by electric space heaters. The heat is uniformly distributed by baffles which induce a circulation of heated air by creating a chimney effect. The sterilizing process is automatically controlled by a hand-reset thermostat which cuts off the power at a predetermined temperature which complies with local regulations.

A large experimental sterilizer, Figs. 1 and 2, has been on test under actual farm conditions since June 1, 1931. It measures 38 by 42 by 50.5 in inside, and is capable of holding 6 cans, 6 lids, 6 pails and a surface cooler. This is about the volume of the ordinary 8-can commercial sterilizer.

[1]Assistant agricultural engineer, Maryland Agricultural Experiment Station. Jun. Mem. A.S.A.E.

The door opening is 30 in wide, the full height of the box, and centered in the front.

Chromalox heating elements are mounted on 1-in porcelain insulators and bolted to the baffles. The two bottom groups are each of 750 w capacity, and the rear group, 1500 w, making a total capacity of 3000 w.

The switch mechanism is semi-automatic in operation, being turned on manually and off automatically. An oven thermostat inserted in the side of the box, actuates an improvised hand-set relay.

The walls are double, of galvanized iron spaced 1 in apart, and insulated with ¾ in of mineral wool pressed between two sheets of metal lath. Five-months operation during warm weather demonstrated this insulation to be insufficient, and the outside of the box, (door excluded, as it was already double insulated) was covered with 1 in of insulating board.

After five months operation the galvanizing peeled off the inside of the box at the corners and other places where moisture collected. This condition was corrected by painting with aluminum paint.

HEATING ARRANGEMENTS FOR PRELIMINARY TESTS

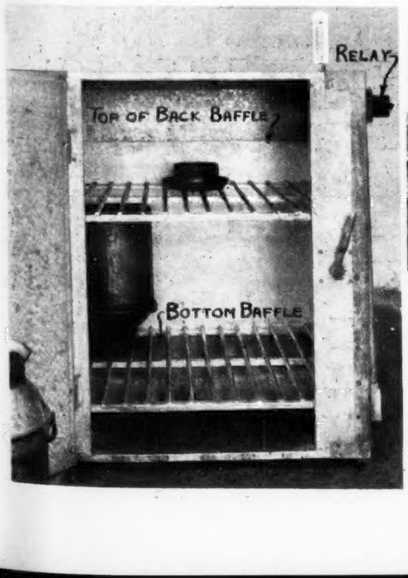
In making the studies to determine the correct heating element and baffle arrangement for even heat distribution, and the preliminary studies for correct wattage and bacteria reduction, a small sterilizer, shown in Figs. 3 and 4, was used. It has sheet metal walls on an angle iron frame, with ½ in of a commercial asbestos insulation in the walls. The insulation for all sides, top, and bottom is completely enclosed in the galvanized iron sheets, giving metal on metal construction at the corners.

The heating elements used were 500-w strip-type space heaters, 1½ in wide and 23 in long. The number and arrangement of these was varied for each test or series of tests.

Temperatures at various places in the box, on the utensils, and in the air, were measured by means of 12 thermocouples and a Brown pyrometer. In taking the metal temperatures the thermocouples were inserted in small tin strips soldered to the cans. These strips held the couples tightly against the can metal.

For the preliminary test, a sterilizing temperature of 220 deg (F) for a 20-min holding period was chosen as a basis of comparison.

Even heat distribution is an important consideration. Where the temperature variation between maximum and minimum utensil temperatures is large, the maximum temperature is high before the minimum reaches the desired limit. As a result, there is danger of melting the solder on the utensils, and the radiation losses are greater, causing an increase in energy consumption. The importance of this tem-



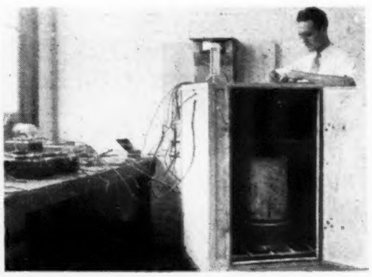
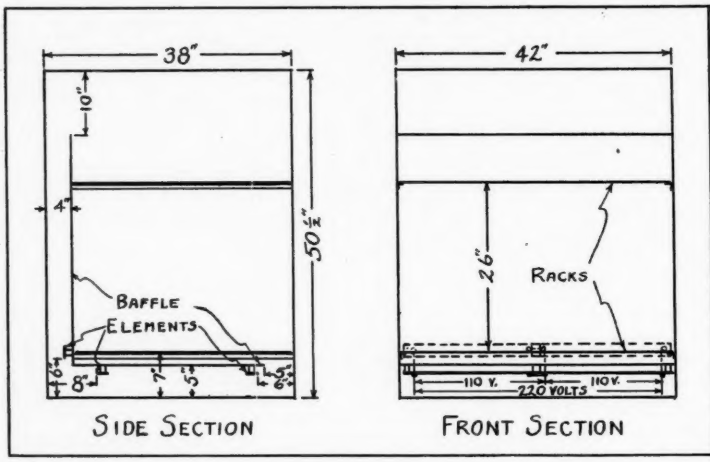


Fig. 1. (Extreme left) Modified steam-electric sterilizer with capacity for 6 or 7 cans, surface cooler, milking machine pails, strainer, etc. Fig. 3. (Left) Small modified steam-electric sterilizer showing test equipment which includes a Brown pyrometer with 12 thermocouples, watthour meter, wattmeter, and voltmeter



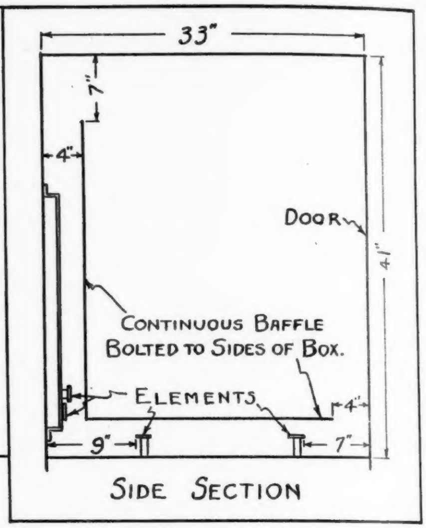


Fig. 2. (Above) Heating element and baffle arrangement for large test box shown in Fig. 1. Fig. 4. (Right) Heating element and baffle arrangement for small test box shown in Fig. 3

perature variation is a primary consideration in the tests of heating element and baffle arrangement discussed below.

Tests were made with the heating elements on the bottom, back, and sides, using five different baffles.

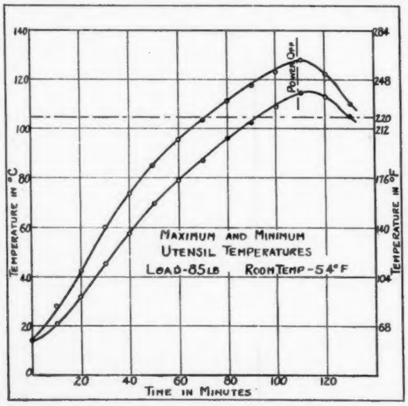
Using a bottom arrangement of elements without a baffle, the solder on the utensils at the bottom was melted before the desired temperature was reached in other parts of the box.

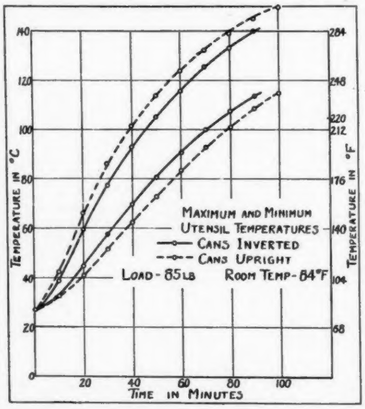
Three different types of bottom baffles were tried. First, an 8 by 24-in sheet of galvanized iron was placed above each of the two pairs of elements used. Second, a baffle bolted to the sides and back of the box, 2 in above the elements, with a 4-in space in front and an opening from front to back through the center, was used. Finally a double baffle with the first bafflle plate 1 in above the elements and the baffle plates 1½ in apart, was used. The lower plate had three rows of six 1¼-in holes between the four heating elements, which were spaced 7½ in apart. The top plate had four rows of five 1½-in holes placed over the heating elements. In the first and second set-ups slight variations in the position of the utensils made marked differences in the temperature variations for successive tests. These variations ranged from 50 to 85 deg. With the double baffle, the heat movement upward was restricted to such an extent as to make the heat losses through the bottom of the box excessive. The temperature differential was 40 deg and the heating time 3½ h, which was 1½ h longer than any other set-up with 2000 w.

With all of the elements placed on the back under a plain sheet metal baffle bolted to the sides of the box and open at the top and bottom, the temperature variation was so great that the lids at the top of the box were excessively hot (302 deg), while the can metal at the bottom was only 198 deg, which is below the desired low limit. It was observed during the studies on this set-up that even heat distribution is aided materially by inverting the equipment. (See Fig. 6.)

The elements were also placed back of baffles on either side of the box, with an accompanying temperature variation of 44 deg. This variation is not excessive, but the space taken up by the baffles was so great as to make this arrangement impractical.

Other arrangements of baffles and heating elements that were tried included using a flue baffle along the bottom and back of the box and placing the elements (1) on the back of the box, (2) grouped at the lower rear of the box, and (3) in two groups on the bottom and one at the lower rear of the box. This last arrangement was found to be the most satisfactory of any tried, the maximum temperature variation being 23 deg. The flue baffle with this arrangement of elements gives a sturdy construction, distributes the heat evenly, and does not require that the utensils be carefully racked. The arrangement for the





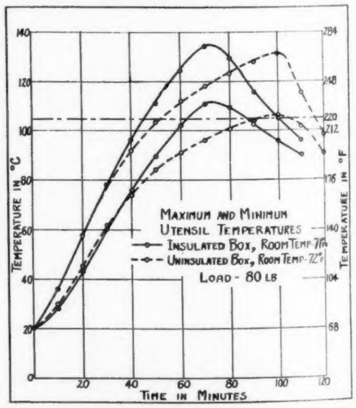


Fig. 5. (Left) Time-temperature curves for heating element and baffle arrangement of Fig. 4, using 2000 w heating capacity. Fig. 6. (Center) Results of comparative tests showing the advantage of inverting the utensils. Fig. 7. (Right) Curves showing the saving in heating-up time resulting from the use of ½-in of insulation

Table I. Performance of Small Experimental Sterilizer

Average Results for Five Complete Tests of Each Temperature and Time (Load—90 lb of equipment)

Minimum utensil temperature, deg (F)	Holding time, min	Bacterial Counts				Power consumption kwh
		Can		Pail		
		Before sterilization	Per cent reduction	Before sterilization	Per cent reduction	
230	30	1,160,100	99.91	71,900	99.66	5.02
230	15	1,293,500	99.94	76,200	99.92	4.84
205	30	1,667,200	99.91	210,500	99.90	3.64
205	15	558,500	99.68	76,000	99.47	3.32
180	30	1,035,400	99.83	179,100	99.52	2.78
180	15	2,564,400	99.78	129,600	99.56	2.60
150	30	574,000	97.62	76,500	99.68	2.12
150	15	1,050,600	96.82	413,900	99.90	1.90

smaller box is shown in Fig. 4, and for the larger box in Fig. 2. Time-temperature characteristics of the smaller box loaded with 85 lb of equipment are shown in Fig. 5.

Another test in the heat distribution studies included the use of a fan, placed for forced circulation, in the center of the top of the sterilizer and directed downward. Heat distribution was aided very little by the fan, the variation being 38 deg.

WATTAGE FOR FOUR-CAN STERILIZER

Wattages up to 3,000 were tried before 2,000 w was taken as the proper capacity for the 4-can box. Wattages above 2,250 showed an increase of as much as 0.17 kwh per run over the 2,000-w set-up. Also, in all cases, the higher wattages produced greater temperature variations than the lower. With wattages lower than 2,000, the box heated up slowly, causing an increase in energy consumption. An early test with the smaller sterilizer empty indicated that it would radiate an approximate equivalent of 1,000 w at a maximum temperature of 284 deg with a room temperature of 65 deg. The connected wattage is closely dependent upon insulation. Tests reported below indicated that better insulation would decrease the necessary connected load, give a more even heat distribution, and reduce the power consumption.

Based upon the performance of the small sterilizer, 3,000 w was chosen as the correct wattage for the larger box.

STEAM STERILIZATION FROM ADHERING WATER

Three series of tests for bacteria reduction were made to determine the proper temperature and holding period for the sterilizer. These are reported in Table I. The utensils upon which the counts were made were in daily use at the University of Maryland dairy; 3 cans, 3 lids, 2 pails, and 1 strainer, totaling 90 lb, were used in making the tests. They were washed and rinsed by the dairyman in the usual manner before being sterilized.

Other bacteria counts were made on utensils from the larger sterilizer operating at 205 deg for 30 min in a farm dairy. Old cans which were battered and rusty were used for these studies. All the utensils—6 cans, 6 lids, 6 pails, and a surface cooler—were washed in about 10 gal of water at approximately 100 deg, then rinsed by pouring 2 gal of 100-deg water from one utensil to another. Under these conditions the highest after-sterilization count showed only sufficient bacteria to raise the milk count 28 per cc. The average of four tests was 16 per cc in the cans and only 0.7 per cc for the milker pails. Counts were also taken on similar utensils after they were sterilized and held in the sterilizer for 12 h without additional heat. These counts checked very closely with those taken on similar utensils at the end of the sterilizing period. The fact that the bacteria counts did not increase and that there was never any moisture to be seen in the utensils was taken as evidence of dryness after sterilization.

In order to determine how nearly this process approached conditions in the ordinary steam sterilizer, the weight of water necessary to produce a saturated atmosphere at 180 deg was computed. Separate weighings of cans, lids, pails, and strainers were made, estimating to 1/10 oz, after the utensils had been rinsed and drained for 5 sec. The same utensils were weighed after the sterilizing process was completed and the utensils were dry. The average weights of adhering water were as follows:

Utensil	No. of Weighings	Adhering Water
Can	9	1.5 oz
Lid	9	0.3 oz
Pail	9	0.7 oz
Strainer	5	0.3 oz

With normal handling the utensils would be placed in the sterilizer immediately after rinsing and would probably carry several times the above weights of water. The water adhering to 3 cans, 3 lids, 2 pails, and 1 strainer averaged 7.1 oz for the above weighings. The calculated amount for saturation in the small sterilizer was 7.4 oz.

Further evidence that sterilization took place in the presence of steam was provided by the escape of steam from cracks around the door during the sterilizing process. When the sterilizer door was opened during sterilization the box was invariably filled with a superheated water vapor.

EFFECT OF ADDED INSULATION

In comparative tests with and without ½ in of the commercial asbestos insulation it was found that nearly 40 min was saved in the heating-up time by using the insulation (Fig. 7).

Mineral wool insulation of ¾-in thickness in the larger box was apparently insufficient as indicated by the effect that changes in outside temperature had on the operation of the box. The sterilizer was located in a farm dairy wash room. With an 8 to 12-deg drop in outside temperature, the energy consumption increased as much as 2 kwh per sterilization. Loaded with 225 lb of utensils the energy consumption was 9.3 kwh per day for October 1931. After covering the outside of the box with 1 in of insulating board, the energy consumption for November was lowered to 7.1 kwh per day.

On January 15 the thermostat was reset to hold the utensil temperature at 185 deg for 30 min. Satisfactory sterilization was obtained and the energy consumption lowered to an average of 5.86 kwh per day for the following two months.

Ten months experience in the use of this sterilizer indicates that it is capable of efficiently sterilizing dairy utensils according to present accepted standards. It possesses the advantages of giving uniform results without attention after putting in the utensils, eliminating the human factor from the sterilizing process, leaving the utensils dry, and being reasonably low in connected load and power consumption.

Head Loss in Flow Through Fine Screens[1]

By M. R. Lewis[2]

IN ESTABLISHING an experimental farm on virgin land at Hermiston, Oregon, it was considered desirable to attempt to screen out all weed seeds from the irrigation water. Upon consideration of plans, wide diversity of opinion as to the necessary area of screens and of the relative effect of screens of different degrees of fineness on the flow of water became apparent.

In order to arrive at some basis for the design of a plant, tests were run on three screens of varying mesh. These tests were very limited, but since it seems that no data of the sort have been published, the results may be of interest. The tests were conducted by the author and Professor F. Merryfield of the department of civil engineering, in the hydraulic laboratory of Oregon State Agricultural College.

The screens were placed across an orifice in a watertight bulkhead in one of the large flumes in the laboratory. The orifice used was 0.25 foot high by 1.0 foot long, but as the screen samples used were only 1.0 foot long, it was necessary to reduce the length of the opening. This was done by tacking a strip of wood about ⅜ inch thick across one end of the orifice, which reduced the area to (0.25 x 0.92), or 0.23 square feet. Two runs were made without any screen over the orifice, in order that the effect of this strip on the coefficient of discharge might be determined. In all cases the orifice was completely submerged.

The rate of discharge was determined by weighing the water discharged during a period of approximately one minute. Time was measured with a stop watch. Loss in head for each run was determined by duplicate readings of a level rod held at the surface of water above and below the bulkhead. A precise level was used for this purpose.

Three samples of woven brass wire were used as follows:

Mesh	Size of wire, inches	Ratio of net area of opening to gross area
20	0.023	0.29
24	0.020	0.27
30	0.016	0.27

Runs were made in series, each series being designated by a letter. Series A, B, C, and D were run with the 20-mesh screen, Series E with the 24-mesh, and Series F with the 30-mesh screen. The data are plotted on the accompanying diagram. As the tests were run it soon became evident that the screens were rapidly obstructed by trash, chiefly fibers of oakum which had been used in calking. The plotted data bring out very distinctly the loss in capacity as the various runs proceeded. After each of Series A, B, and C runs, the flume was drained and the screen carefully cleaned. During the subsequent series the screens did not become foul so quickly, and it was possible to keep them reasonably clean throughout each series of runs.

Taking this condition into account there is little in the data to justify doubt that the loss of head through the screen follows the usual orifice law represented by the formula, $Q = CA\sqrt{2gh}$. Lines representing this formula have therefore been drawn on the graph, through the point of maximum relative discharge for each screen. From the intercept at $h = 1$, values of C for each screen on the basis both of the net area of opening in the screens and of the gross area of the orifice have been calculated as follows:

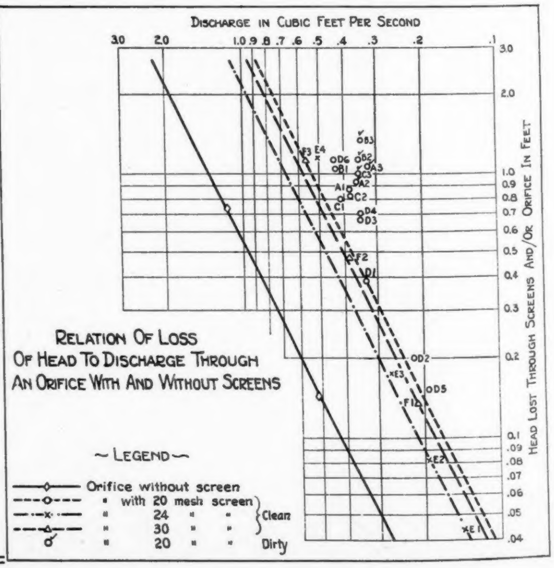
Screen	C for net area of opening	C for gross area of orifice
20	1.02	0.29
24	1.36	0.37
30	1.17	0.32
No screen		0.74

From these data no conclusion is possible as to how much of the reduction in flow below that represented by $C = 1.0$ for the gross area of the orifice is due to obstruction by the screen and how much to the contraction which was present at the orifice without the screen. On the assumption that all of the reduction was due to the screen, the discharge through a clean screen of these mesh sizes might be determined from the formula as approximately

$$Q = 0.33\,A\sqrt{2gh},$$

Where Q is the discharge in cubic feet per second
A is the gross area of the screen in square feet
g is the acceleration due to gravity (32.2 feet per second)
h is the loss of head caused by the screen in feet.

At low velocities (less than 1 foot per second) the loss of head is negligible for practical purposes. It is hoped that further tests will be made on loss of head through the screens which it is proposed to install at Hermiston. Provision is being made in the design of the plant for a limited range of experimental work.



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[1]Prepared under the direction of W. W. McLaughlin, chief, division of irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture, and in cooperation with the Oregon Agricultural Experiment Station.

[2]Irrigation engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

A comparatively new approach to the weed control problem in irrigated areas is the separation of weed seeds from irrigation water by screening. The limited experiments reported indicate that at low velocities the loss of head due to screening is negligible and that further experiments might develop a practical commercial practice

Probable Frequency of Serious Nation-Wide Droughts in the United States[1]

By J. B. Kincer[2]

IT IS DIFFICULT to make a statistical comparison of droughts, because of the many modifying elements that enter into the question, especially when considered from the standpoint of resultant damage to crops and other vegetation. It is easy enough to compare rainfall deficiencies, for different years, with the normal as a base, for a single meteorological station, or even for a state, but for extended areas, efforts at a quantitative comparison become complicated because of the marked variations in geographic distribution of precipitation from year to year.

There are also other modifying features, among which may be mentioned the amount and character of the rainfall immediately preceding the drought period; the season of the year in which the drought occurs; the distribution and character of the rain that does fall during periods of general deficiency; the rapidity with which the soil dries out, as depending largely on its texture and water-holding capacity; and the temperature conditions as affecting the rate of evaporation.

Most of these modifications apply even in comparatively limited areas. When we undertake to set up certain drought years, for a statistical comparison on a nation-wide basis, the task becomes all but hopeless. Notwithstanding these difficulties, records for the drought of 1930-31, when its duration, areas covered, and deficiencies in rainfall are considered, show that it easily takes first place in the climatological history of the country.

Briefly reviewed, the shortage in precipitation in this, the latest and most severe drought of record since meteorological data adequate for nation-wide comparisons have been available, appeared first in the Northwest in 1929, and in the Middle Atlantic states during the winter of 1929-30. In the spring of 1930 it overspread the Ohio and middle Mississippi Valleys, and, beginning with June, extended south to the Gulf of Mexico. In July, the drought area was widened to include nearly all of the country east of the Rocky Mountains, with only New England and Georgia having as much as normal rainfall for that month. The spring and summer combined was the driest of record in Missouri, Illinois, Indiana, Ohio, Kentucky, West Virginia, Maryland, and Pennsylvania. The summer was the driest in Arkansas, Tennessee, and Mississippi For the year, as a whole, 40 of the 48 states had less than normal rainfall.

Substantial to heavy rains in the fall of 1930 brought relief to the South and the interior states, but it continued dry in the upper Ohio Valley and middle Atlantic area. The winter of 1930-31 was characterized by abnormal warmth, and, except in the extreme Southeast and the Southwest, by markedly subnormal moisture. In the Northwest the dryness was especially marked, some states having only one-third the normal amount of precipitation. It was the driest winter of record in Indiana, Illinois, Michigan, Wisconsin, Iowa, Minnesota, North Dakota, Montana, Wyoming, and Oregon. The spring and summer months of 1931 had unusually well-distributed and mostly sufficient moisture for current crop needs in nearly all of the principal agricultural sections of the country, except the Northwest, the Eastern States especially being favored with more than normal rainfall. The northwestern drought, however, was severe, with devastating effects on growing crops and other vegetation, aggravated by several years of accumulated deficiencies in moisture in that region. The drought centered in western North Dakota and eastern Montana, with the growing season of 1931 the driest of record over a considerable area, including the Dakotas and Montana.

With abundant top-soil moisture in the central valleys and Central-Northern States, during the fall just closed, the drought area shifted to the South, and especially the Southeast, where it became severe. The fall of 1931 was the driest of record in many places from Virginia southward to Florida, but at the same time rainfall was heavy in most of the theretofore dry central-northern localities, with many stations in the upper Mississippi Valley reporting the heaviest November rainfall ever known. Thus the outstanding deficiencies in rainfall during 1930-31 have shifted from the middle Atlantic area to the interior valleys, then to the South, and later generally over the country. More recently there was a shift in extreme dryness from the Northwest to the Southeast.

TEMPERATURES ABNORMALLY HIGH

In addition to the very unusual character and distribution of rainfall during the past two years, temperatures have been unusually high. Many localities had the highest of record during the summer of 1930, while the winter of 1930-31 was one of the warmest ever known. In addition, the summer of 1931 had mostly above-normal warmth, and many districts experienced the highest temperatures of record for so late in the season during the fall just closed. For example, a north-central area, comprising Montana, the Dakotas, and Michigan, has had above-normal temperature every month, except one, since January 1930, while for the current year, considering the country as a whole, March only was appreciably colder than normal, May slightly cooler than the seasonal average, and all other months warmer than usual.

In a study of droughts, from an agricultural standpoint, the season of the year in which the deficiencies in rainfall occur is of the utmost importance. While serious shortages in the important summer growing season are usually reflected in the annual amount, this is not always true. Arkansas, in 1930, had an annual rainfall of 96 per cent of normal, in view of which in years to come it would not be surprising to find someone listing that state as outside the 1930 drought area, if the annual amount of rainfall alone be considered. As a matter of fact, it heads the list of states most severely affected, because of the extreme summer dryness which was balanced by heavy rains in the spring and fall months. As to summer conditions, Little Rock, for example, had only slightly more than 0.1 in of rain from the first of June to the first of August.

In an effort to make a satisfactory comparison of the 1930-31 drought with preceding droughts, as affecting the entire area east of the Rocky Mountains, we have considered nine separate meteorological divisions, as follows: New England; the middle Atlantic area; the Ohio and middle Mississippi Valleys; the western Lake region and upper Mississippi Valley; the northern Great Plains; the central Plains; the west Gulf section; the central Gulf states, and the south Atlantic area. For each of these, the normal warm-season (March 1 to September 1) rainfall was computed. and the per cent of normal determined for each of the 41 yr from 1891 to 1931, inclusive. When the data are charted in convenient form for comparison, the preponderant lack of uniformity in geographic distribution of rainfall at once becomes apparent. In 11, or more than one-fourth of the 41 yr, the signs of departures from normal for the several areas are divided four to five for the nine

[1]A paper presented at a meeting of the Land Reclamation Division of the American Society of Agricultural Engineers at Chicago, December 1931.

[2]Senior meteorologist, in charge of division of agricultural meteorology, Weather Bureau, U. S. Department of Agriculture.

sections; that is, for this large percentage of years there is as near an even division of above and below-normal values as we can have with the odd number of regions. In 20 of the 41 yr at least one-third had a departure sign at variance with the majority, and the minus sign was general in only 3 yr — 1910, 1925, and 1930 — all in the last half of the 41-yr period. Above-normal rainfall was general only once, in 1920.

When all areas are considered, we find four other droughts somewhat similar to that of 1930-31 during the last 41 yr. The first was in 1894-95, most severe over the northern half of the country. It did not reach the Southwest, as the central Great Plains and west Gulf areas had more than normal rainfall in those years. In 1894 the average deficiency from normal precipitation during the spring and summer for the nine regions above described, was 17 per cent, and in 1895, 3 per cent, the carry-over in 1895 being mostly in the north-central states. Following this drought, except for a moisture shortage in the South in 1896, there was a period of 14 yr, up to 1910, with only two, 1896 and 1899, having deficient warm-season rainfall, on the average, for the nine sections, and these only slightly subnormal. The second general drought appeared in 1910-11, with average deficiencies of 16 per cent and 9 per cent, respectively, and the third in 1917-18, with respective average shortages of 7 and 12 per cent. The fourth drought included 1925-26, with a 24 per cent deficiency for the former and 7 per cent for the latter. The three years, 1927-29, had mostly above-normal rainfall, except for a deficiency in the Northwest in 1929. Then came the great drought of 1930, holding over in some areas into 1931. The average warm-season deficiency for the nine areas in 1930 was 25 per cent, and in 1931, 10 per cent. The intervening years between the five droughts here outlined that were more or less general over the nine areas during the 41 yr, were 14, 5, 6, and 3 yr, respectively.

Other droughts of a more local character have occurred, such as that covering the Gulf and South Atlantic states in 1896, with an average deficiency in rainfall of 29 per cent; that in the Ohio and upper and middle Mississippi Valleys, the central Plains, and west Gulf area in 1901, with 22 per cent deficiency; the central Plains and west Gulf area in 1913, with a 30 per cent shortage, and the northern Great Plains in 1919, with 26 per cent below normal. Considering these nine areas separately, the driest growing season for each was as follows: New England, 1894; middle Atlantic area, 1930; Ohio and middle Mississippi Valleys, 1930; the upper Mississippi Valley, 1910; the northern Plains, 1931; central Plains, 1913; west Gulf area, 1896; central Gulf states, 1925; and the south Atlantic area, 1925.

Most of the nine regions had above-normal rainfall during the spring and summer months for the three years immediately preceding the great drought of 1930, but the upper Mississippi Valley and northern Great Plains have been persistently dry for several years, six of the last seven years being decidedly dry in the former, and six of the last eight years in the latter. This accumulation in deficient moisture aggravated the effect of the 1931 moisture shortage in these regions.

The preceding discussion of droughts, on a regional and country-wide basis, covers the period of time for which meteorological data are available by state-wide averages. Obviously, more satisfactory conclusions could be drawn if longer records were at hand. For this 41-yr period, where a large number of records are included, there is clearly shown a marked lack in uniformity in the recurrence of droughty years, with a substantial percentage of the total years of the period showing decided geographic variations from region to region.

A study of earlier droughts is less satisfactory, because of the lack of adequate data, but available records show a decided deficiency in rainfall during the summer of 1881 in the interior valleys and more eastern states. We have also a few individual records covering from 80 to more than 100 yr in different parts of the country, which give an indication of at least local conditions from year to year for more than a century. Three of these long records may be considered for our present purpose: St. Louis, Mo., covering 94 yr; Marietta, Ohio, 105 yr, and New Bedford, Mass., 117 yr. The St. Louis data show the following years with annual precipitation 25 per cent or more below the normal: 1837, 68 per cent of normal; 1860, 75 per cent; 1870, 60 per cent; 1871, 59 per cent; 1879, 65 per cent; 1894, 69 per cent; 1900, 75 per cent; 1901, 63 per cent; 1917, 63 per cent, and 1930, 59 per cent. The lowest years of record were in 1871 and 1930, with 59 per cent of normal in each year, the former being preceded by a dry year. The Marietta, Ohio, record shows large deficiencies in 1871, with 69 per cent of normal; 1879, 72 per cent; 1894, 72 per cent; 1895, 63 per cent; 1904, 62 per cent; 1910, 74 per cent, and 1930, 54 per cent, 1930 being the driest of the 105 yr. New Bedford does not show a single year with as much as 25 per cent shortage in rainfall for more than 100 yr, from 1814 to 1918, when there was a 27 per cent deficiency. In 1923, precipitation averaged only 69 per cent of normal, and 1930, 62 per cent, the latter being the lowest for 117 yr. Also at this station there have been as many years with less than 85 per cent of normal rainfall in the last 14 yr as in the preceding 103 yr.

LONG-TIME RAINFALL TRENDS

We have added to these three long-record stations Sacramento, Calif., covering 81 yr, and computed for each of the four the average annual precipitation for the entire period of the record; also the 20-yr progressive means, by considering the years numbered 1 to 20 for the first, 2 to 21 for the second, and so on through the series. The percentage of the long-time, or complete-record, average that was represented by the several successive 20-yr averages was then determined and plotted consecutively. These show, for Sacramento, a definite upward trend of precipitation for 29 yr from the beginning of the plotted curve to 1897, then a recession for 33 yr to the present time, the differences between the high and low points of the curve representing 35 per cent. St. Louis shows rather marked opposite trends from those at Sacramento, with a more or less gradual decline in the plotted curve for 42 yr from 1867 to 1908, followed by a recovery of about 8 per cent to 1928, the difference between the high and low points of the curve being about 25 per cent, with a subsequent recession.

Marietta, Ohio, shows much shorter and less marked trends: Upward for 23 yr, from 1845 to 1867; downward 12 yr, 1868 to 1879; upward 13 yr, 1880 to 1892; downward 18 yr, 1893-1910; upward 19 yr, 1911-1929, and then a recession in 1930, with the extreme variation for the entire record only about 10 per cent. New Bedford shows a downward trend of 16 yr, from 1841 to 1856; then a long, gradual, upward trend, covering 49 yr, from 1857 to 1905, and a marked recession of about 25 per cent from 1906 to date. In studying these records, it is interesting to note that those representing the extreme East and extreme West, New England and California, have much in common with regard to long-time trends, as do also those for the interior, but oppositely directed from those in the East and in the West.

Oppositely directed trends in precipitation are by no means confined to widely-separated areas, as they sometimes appear even in nearby states. Iowa and Illinois afford a striking example of such opposition. When we compute the percentage of normal precipitation from year to year for each of these states, and smooth the resulting data to eliminate short-period fluctuations, it is found that, in Iowa, there was a very definite rise in the rainfall curve of nearly 20 per cent during the 16 yr from 1887 to 1902, and a fairly uniform descending trend, amounting to about 15 per cent, during the succeeding 28 years to 1930. The Illinois curve shows, after an abrupt drop of about 25 per cent from 1883 to 1894, a more or less gradual recovery for more than 30 yr up to very recently when a recession set in. The recovery in this case from 1894 to 1927, was about 15 per cent. Here we have for two neighboring

states oppositely directed precipitation trends during the last quarter of a century.

In studying the question of variations in rainfall, especially in relation to droughts or the recurrences of periods of deficient moisture, it is often best to consider the element of time by the use of monthly data, instead of annual or seasonal values. A drought may begin or end intermediately with regard to either the year or a season, and in such case its actual duration is indeterminate, unless monthly data are used. Also only restricted areas, as nearly climatically similar as possible, should be considered in a single study where details are desired. Again, there are marked seasonal trends in different sections of the country, such as the eastern type of rainfall, with comparatively uniform distribution through the year; the Plains type, with a summer maximum, and the Pacific type, with its summer dryness.

In considering the matter on a monthly basis, it is necessary to eliminate those normal seasonal trends, or annual march, as they are sometimes called, and a good procedure in such cases is to reduce all monthly values to a "per cent of normal" basis for the separate months. The data then become comparable for a study of abnormalities which may begin or end at any time within the year.

Cobblestone Walls for Buildings

By W. H. McPheters[1]

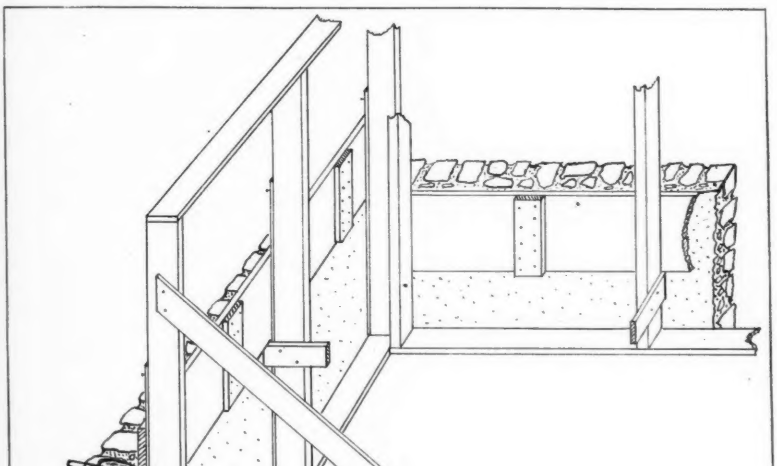
ROCK AND SAND are so plentiful in many parts of the country that they are looked upon as a nuisance and not thought of by many people as a common building material. The term "cobblestone" will be used in this article to mean work done with various kinds of rock since the method of construction is the same. Most people think of cobblestone as being round, smooth rock. The modern meaning is applied to work where any field stone or broken rock is used, so long as they are put into the wall by the method of laying cobblestone.

Buildings made of cobblestone are beautiful and attractive. Very artistic buildings may be constructed of cobblestone in sections where rock of various colors can be had to work out color schemes, or to make the main building of one color and use another color for such decorations as around windows and doors, porch columns, and the water table.

Buildings made of cobblestone, in addition to being beautiful, are permanent. They are massive and consequently not liable to be damaged by wind. The walls are fireproof and require no painting or repair work. In most cases when rock and sand are plentiful, the first cost is very little, if any, more than for a frame building. Another advantage of cobblestone construction is that almost anyone can construct many of the simple farm buildings and do the work, a little at a time, as his regular work permits.

Various types of rock can be used in cobblestone work, in fact almost any type of hard field stone or broken rock.

For walls to be made of field rock, that is small rock from fields and pastures, it is well to gather up rocks of various sizes rather than have them all of about one size. It is also advisable to have them piled up ahead of time so that rains will wash them, as they must be clean. There are three general types of field rock. The irregular-shaped nugget; the round, smooth boulder, and the flat thin rock. Each of these will make a distinct type of wall.



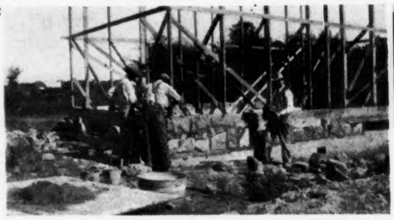
Cobblestone wall under construction, showing back form and position of stone and mortar

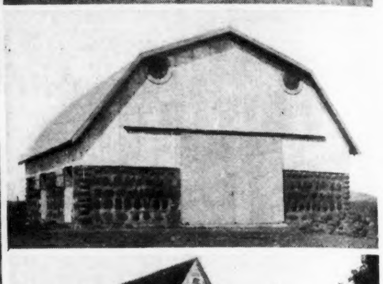
Irregular chunk rock works up into a rough cobblestone wall. The joints may be left rough, or a neater wall made by brushing them out with a whisk broom and water. In this process the rocks are washed off clean and the joints sealed. The rock should project out one to two inches beyond the mortar so as to make the rocks stand out as individuals, rather than have the mortar joint stand out. The mortar spoken of here is really concrete, as it is made of sand, gravel, and cement.

It is also possible to point the joints with colored mortar instead of brushing them out with a whisk broom. In this case the mortar joint is the prominent part of the work. This requires much more time and skill, and personally I do not like it so well as it looks more artificial. The rubbed or washed joint is neat and appears more like the work of nature.

Round boulders also work up into attractive buildings. Some peo-

[1]Extension agricultural engineer, Connecticut Agricultural College. Assoc. Mem. A.S.A.E.





(Upper left) A house wall being laid up of broken rock, flat face out. (Upper right) A 20x80-foot poultry house of irregular cobblestone. (Center left) A milk house of flat rock with flat edges and an occasional flat side laid out. All the work was done by a dairy farmer and his dairy help. (Center right) A round boulder barn wall. (Lower left) A cobblestone home with pointed joints. (Lower right) A broken rock camp house

ple like the effect better than that of the irregular field rock. Personally I prefer the irregular shape and size. Round rocks of nearly the same size tend to lay up in rows that appear artificial. These may be horizontal, both horizontal and vertical, or haphazard. The most attractive buildings built of either irregular field rock or round boulders are those in which the rock are placed at random, as though they had been shot into the wall with a shotgun, rather than placed in rows. Round boulder buildings are practically always finished with rubbed joints.

Flat, thin field rock, when laid flat, should project about two inches beyond the mortar in order to make them stand out clearly. The rubbed joint is preferable when the thin edges are laid out. If the flat side is laid out the wall appears to have been made of large rock. Here the joints may be brushed out with a whisk broom, but not deeply, or pointed with colored mortar. Both the pointed and the washed joints are very attractive in this type of work.

Another type of cobblestone work is made of broken rock. These are obtained by breaking large rocks into various sizes and shapes. This type of work is most attractive when laid with the face out, that is, most nearly flat. The joints may be finished with a whisk broom and water, or pointed. The work is practically the same as that of the irregular field rock, except that the freshly broken surface is exposed instead of the round, weather-beaten, rustier face of the field stone.

HOW TO BUILD WITH COBBLESTONE

A form of some kind is used on the inside of the wall. A solid board wall may be erected, but this requires considerable lumber. The method I use is to place 2x4-inch studding about 3 feet apart. (The studding may be of any available length, as the length needed for rafters or interior studding.) They are plumbed and well-braced from the inside only, and the corners of the form are squared.

Place a 1x12-inch plank all the way round the building on the outside of the studding, which is the inside of the wall. This board should be well greased on both sides. It is also well to nail a series of 1x4-inch cleats across to help keep the board from warping. Then slip a lath between the board and each stud, so the board can be loosened for raising. The rock is laid all the way round the building the height of the board; then the board is raised. It is better to lay the foot height in two courses, for if it is laid in one course the rock is liable to slip. The courses will not be left level, due to the varying sizes of the rocks. The board may be raised two times a day, or, in very warm weather, possibly three times.

In laying the rock use a mortar of 1 part cement to 4 parts sand, or 1 part cement to 5 or 6 parts of half sand and half gravel. This concrete is placed on the wall against the plank with a shovel, the rock is laid in place and pulled out to the desired thickness of the wall by placing the point of the trowel against the plank and pulling the rock out to a mark on the handle of the trowel the desired thickness of the wall. Small rock may be placed in the mortar back of the rock. Be sure to tamp the concrete in around each rock with the trowel so as to fill all spaces. Tap each rock with the handle of the trowel as soon as it is in proper position. This causes the rock to settle into the concrete and adhere to it. Be sure there is a little space between the rock and the board for mortar; otherwise there will be holes on the inside of the wall.

The interior of the cobblestone wall appears as a monolithic concrete wall. If insulation is not necessary, plaster may be put directly on the concrete wall, but for houses it is advisable to fir with 2x2-inch boards, then lath and plaster. This gives 2 inches of air insulation. About the only other buildings that would need to be insulated would be the ice house, the brooder house, and probably the poultry house.

One sack of cement and about 500 pounds of sand and gravel will make concrete sufficient to build 8 to 10 square feet of 11 or 12-inch wall. There is no method of figuring the exact amount of concrete in the cobblestone wall, for spaces between rocks are variable. However, it is found that about one-half the wall is concrete and one-half rock.

The thickness of the wall to be used will depend on the type of building. In the northern states, where the winters are severe, it is not advisable to build any wall much less than one foot thick. For a poultry house a ten-inch wall is sufficient if insulation is to be used. For a house it is advisable to make the wall 10 to 12 inches thick where it is to be firred and lathed. For barns and other buildings where no insulation is to be used, the wall should be made about one foot thick. The effective thickness of a one-foot wall with brushed joints is only about ten inches, for the rock projects about one to two inches beyond the mortar.

It is unfortunate for a person who needs or wants certain buildings not to have them, where there is plenty of high-grade low-cost material available. To build with cobblestone on the farm one should plan ahead and do the work with time that would not produce a cash income. It has been done by many farmers in some states, and what has been done can be done wherever the material is available.

(EDITOR'S NOTE: About six years ago the author started holding cobblestone building demonstrations and exhibits at county and state fairs in Oklahoma. There was practically no cobblestone work in the state at that time. At the end of five years he had a record of about 2000 cobblestone buildings, many of which were built by farmers. This indicates that many people desire to learn how to use their native rock in building.)

Measurement of Orchard Heater Smoke[1]

By F. A. Brooks[2]

IN THE southern California citrus districts approximately 70,000 acres are provided with a total of 3½ million simple light-weight, sheet-iron heaters worth probably a total of $5,000,000. During the Christmas season of 1930 a prolonged period of low temperatures required firing of about half of these orchard heaters for frost protection, in some localities thirteen nights out of fourteen. The accumulation of smoke was so great that it even interfered with traffic in Los Angeles harbor. The character of the smoke was such that white dogs turned black, all birds looked alike (black) and even closed windows could not prevent damage to furniture, draperies, clothes and merchandise. Personal discomfort was so intense that agitation to stop the smoke nuisance led the Los Angeles Chamber of Commerce to deal with the problem by a committee[3] representing the public, packers, and growers.

Mr. Paul Armstrong, general manager, California Fruit Growers Exchange, stated that more than one-third of the fruit would have been destroyed if the growers had not heated, and he called attention to the fact that the citrus fruits alone are second only to petroleum as a source of wealth in the state. Bearing in mind that the year's production, estimated by Mr. E. E. Kaufman[4] federal-state statistician, realized the growers about $53,000,000, the enormous value of frost protection is evident. Even one filling of these orchard heaters requires 2500 tank cars, which in itself is a 10-day transportation problem. Keeping adequate stock at refineries, and the insufficiency of local facilities for storage also present serious difficulties. The demand for manual labor available to fill, light, and regulate these heaters comes simultaneously throughout the citrus district and usually encounters a shortage because this work has to be done at night and when temperatures are below freezing.

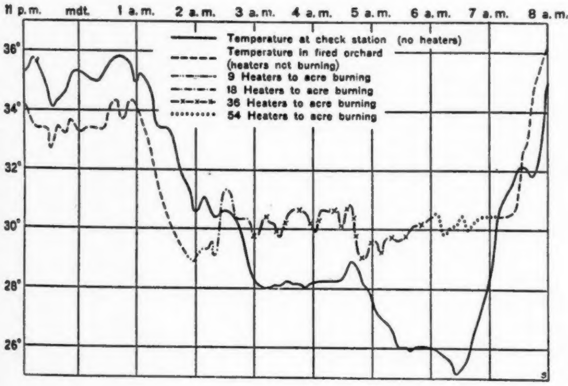
The effectiveness of orchard heating is shown in Fig. 1. The radiation frost has peculiar characteristics in that the air, cooled mainly by contact with the ground and other surfaces which radiate rapidly on clear calm nights, tends to settle in low areas underrunning the warmer air which is relatively lighter. A wind would mix the warmer air with the cold and decrease the probability of frost, but on calm nights, even on a flat plain with no influx from surrounding hills, the air next to the ground will cool rapidly.

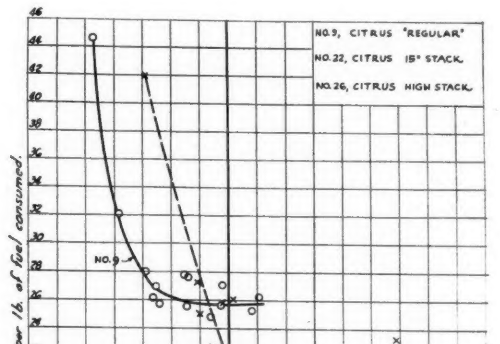
[1]Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at Sacramento, California. January, 1932.

[2]Associate agricultural engineer, University of California.

[3]"Orchard Heating Regulations Considered at Mass Meeting," California Citrograph, Vol. 16, No. 4, pp. 145, 180, 181 (February, 1931).

[4]Southern California Crops, Vol. 8, No. 1, Los Angeles Chamber of Commerce, p. 34 (January 1932).





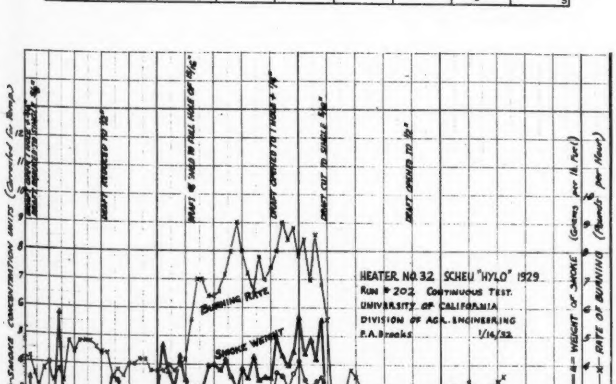


Fig. 1. (Upper left) Effectiveness of orchard heating. April 13-14, 1919, under difficult conditions with temperature inversion only 3 degrees (Fahrenheit) in 35 feet. (From California Agr. Ext. Cir. 40). Fig. 2. (Above) Point test of smoke from citrus heater with different stacks available, 1930. Fig. 4. (Lower left) Continuous test of smoke from a "Hy-Lo" 1929 model heater made by Scheu Products Co.

This usually creates a "temperature inversion,"[5] which fortunately acts as a virtual ceiling, because the cold ground air, if uniformly heated a few degrees, will rise only a short distance before reaching a level of common density, thus limiting the volume to be warmed. This advantage in uniform heating is the reason for using a large number of small heaters.

The belief that the smoke itself helped to conserve the heat in an orchard was widely accepted because of the fact that low clouds prevent radiation frosts. However, the smoke screen is relatively thin. The reduction in radiation rate due to a heavy smudge was measured by Young and Kimball[6] who found a decrease of only 10 per cent. This is insignificant as it might not affect the minimum temperature reached.

Because of the darkness and general smokiness throughout the district, the differences in smoke output of various types of heaters can not be measured by the usual methods of visual comparison of blackness with a standard Ringelmann chart[7]. The greater or lesser density of smoke near orchards uniformly equipped with any single make of heaters could be surmised only very roughly. Large variations in smoke character are to be expected as the heaters burn any kind of oil whose pour point is below 30 degrees (Fahrenheit), and, furthermore, at any bowl level, with large variations of bowl and stack temperatures, with almost no control over air-fuel ratio, and with secondary combustion sometimes above the stack. To control this smoke nuisance some definite method of measuring such smoke was required, and therefore, the University of California was called upon to determine the smokiness of the various heaters in use and to develop a field apparatus suitable for use in the enforcement of smoke abatement ordinances.

Previous work by the University in the general subject is reported in Bulletins 304, 398, and 442, the latter two being reissued in 1930 as Extension Circular No. 40[8]. The present special study of smoke output by heaters was undertaken in February 1931 when the late A. H. Hoffman and C. E. Barbee, both of the Division of Agricultural Engineering, went into the Pomona district at the urgent request of the committee[3] organized to deal with the smoke nuisance.

Sampling by an aspirator had been used before to indicate smokiness by the soot collected on a felt filter. However, the attempt to extend this simple method to obtain weighable samples on light paper proved unreliable for three reasons: (1) The smoke deposit could not be determined because even weighing in an air-controlled chamber with complete reconditioning for moisture content, the final weight of the filter paper varied both plus and minus from the original, due mainly to variable loss of oil processed in the paper; (2) the samples were not dependable because it was impossible to draw them from the center of the waving flame tip exactly; and (3) occasional breezes disturbed the weighing and affected stack combustion. These difficulties forced the complete reframing of the project and the development of new test methods. The work on the new laboratory apparatus started by Prof. Hoffman was continued by Mr. Barbee and W. R. Schoonover, extension specialist in citriculture.

For these determinations all the products of combustion and some outside air were drawn into an apparatus containing (1) a transverse beam of light which the smoke particles partially intercepted, (2) a sampling device of known displacement, and (3) an orifice for measuring the rate of flow. The obscuring power of the smoke was indicative of the density of its carbon content when the opaqueness was evaluated in terms of weight by chemically analyzing the sample of known volume. Then by measuring the rate of flow the total weight of carbon could be determined. This was independent of the amount of outside air accompanying the products of combustion, because any change in dilution simultaneously altered the obscuring power and the carbon content per unit volume. The light interception method calibrated for weight proved ideal for laboratory work as it gave instantaneous readings of smokiness and required little calculation. Fig. 2 is a typical example of the smoke measurements obtained. It shows clearly the changes in smokiness with different stacks on the same heater. The normal burning range is from 3 to 8 pounds per hour, averaging about 4½ pounds.

Mr. Schoonover accompanied by the author, presented twelve such graphs of the first test results on the major types of heaters to the committee[3] on September 4, 1931. These formed the basis of the committee's decision specifying smoke of over 20 grams of carbonaceous matter per pound of fuel burned as intolerable. This limit would exclude approximately 50,000 garbage pail heaters, about 300,000 old-type smudge pots, and over one million stub-stack heaters such as Nos. 9 and 22 plotted in Fig. 2. In contrast to these there are heaters visibly smokeless over the usual burning range giving off only 2 to 5 grams of carbon per pound of fuel.

IMPROVED LABORATORY APPARATUS

To obtain more detailed information needed for the design of stacks, draft devices, etc., to improve the "intolerable" heaters, the laboratory apparatus was revised to triple its smoke sensitivity and obtain continuous readings. Tests are now proceeding with different kinds of oil at different air temperatures and with clean and dirty heaters of a few major types.

The laboratory apparatus now in operation is shown in Fig. 3. The heater being tested is placed on scales under the hood at the extreme right. The scales are self-balancing in that the beam carries one end of a chain (like a "chainomatic" balance) and a mercury contact. When the beam is in the low position, the contact operates an auxiliary device to raise the other end of the chain thus lightening the beam load. To increase the sensitivity of the scales an electromagnet in series with an ordinary light flasher causes the beam to oscillate regularly. The frequency of the contact period being constant, it is its duration that controls the winding-up device. This duration of the contact period is governed by the average position of the beam thus keeping the scales in perfect balance. A vernier slide attached to the winding-up mechanism indicates accurately the loss of fuel weight, and hence the burning rate.

A centrifugal fan shown at the extreme left draws the smoke stream with some surrounding air into the hood and up through a 6-inch stack into a 10-inch horizontal pipe. This sudden change of section and right angle turn serves to thoroughly mix the smoke particles with the air giving a stream of uniform opaqueness under steady burning conditions. The smoke stream is then flattened to 4¼ inches and spread horizontally to 24 inches where it crosses the path of the light beam. Small air holes in the 4-inch pipes (enclosing the light beam), drilled near the channel wall, allow just enough additional air to seep in to prevent the smoke from swirling out into the light tubes. (Glass screens could not be used to confine the smoke stream because they would become coated with soot.) The sharpness of boundary and uniformity of smoke spread was tested by a felt string left in the line of light just long enough to become gray with soot.

For a light source a standard Balopticon, 1,000-watt lamp and its concave mirror is used. On the far side of the smoke stream a condensing lens focuses the parallel rays on a radiation pyrometer sensitive to light. The voltage impressed on the source lamp is held constant at the low value of approximately 65 volts which produces

[5]Young, Floyd D. "Nocturnal Temperature Inversions in Oregon and California." U. S. Monthly Weather Review, Vol. 49, No. 3, p. 145 (March 1921).

[6]Kimball, Herbert H., and Floyd D. Young, "Smudging as a Protection from Frost." U. S. Monthly Weather Review, Vol. 48, p. 461-62 (August 1920).

[7]Faust, H. M. "Smoke and Its Prevention." Ohio State University, Engin. Expt. Sta., Cir. 24, p. 12 (1931).

[8]Schoonover, W. R., R. W. Hodgson, and Floyd D. Young. "Frost Protection in California Orchards." California Agr. Ext. Cir. 40. (1930).

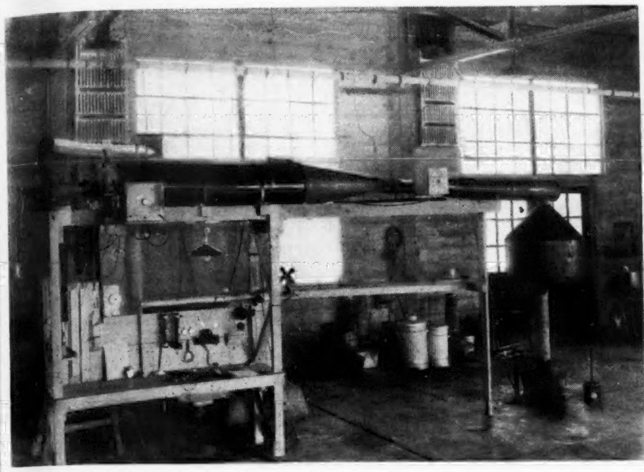


Fig. 3. (Left) Laboratory apparatus for measuring orchard heater smoke. Fig. 5. (Above) Field apparatus for measuring orchard heater smoke

a pyrometer reading of 15 millivolts with clear air. This setting is checked before and after test. The opaqueness of the smoke is indicated by a decrease in the electromotive force of the pyrometer and is measured in successive concentration units[9] of 10 per cent interception. That is, one concentration unit reduces the millivolt reading to 13.5, two units to 12.15, three units to 10.935, etc. The smoke stream temperature at the light beam is noted and the value in concentration units is then increased by the correction for temperature to a standard density basis.

From the light the smoke stream passes into a large drum 18 inches in diameter through a honeycomb of ¾ inch tubes 3 inches long and slowly approaches the orifice plate. Three orifices are provided: One large central orifice (3 inches in diameter) for measuring total flow and two fractional orifices to obtain 1 per cent samples for carbon collection. One of these serves an electric precipitator; and the other serves a Buchner funnel for chemical analysis, or a felt for photometric comparison. The pressure drop across each small orifice is balanced exactly with the main orifice by butterfly valves some distance downstream. Thus by calibrating the flow of the small orifices[10] in relation to the main orifice[11], a definite fraction of the total flow can be obtained unaffected by the temperature or pressure which apply alike to both metering elements. Calibration of the main orifice was accomplished by using a special elliptically rounded approach nozzle with a Venturi expanding cone[12] (to regain sufficient energy to keep within the pressure head available with the centrifugal pump). The flow through the fractional orifices was measured in a large displacement tank by a stop watch, noting the rate of discharge of water which was regulated to balance the manometer between the downstream taps of the large and small orifices.

Both the pressure differential and temperature are observed at the orifice for the calculation of air flow. This leads to the evaluation of light interception in terms of smoke weight when including the time ratio of taking the sample and burning one pound of fuel.

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[9]Simon, A. W., L. C. Kron, C. H. Watson and H. Waymond. "A Recording Dust Concentration Meter." Review of Scientific Instruments, Vol. 2, No. 2, p. 67-83, February 1931.

[10]Hodgson, John L. "The Laws of Similarity for Orifice and Nozzle Flows." Trans. Amer. Soc. Mech. Engrs. Fuels and Steam Power. Vol. 51, No. 42, p. 303-32.

[11]Bean, H. S., E. Buckingham and P. S. Murphy, "Discharge Coefficients of Square-edged Orifices for Measuring the Flow of Air." Bureau of Standards Jour. Research, Vol. 2, No. 3, p. 561-658 (March 1929).

[12]Wien-Harms, "Handbuch der Experimental physik, Hydro— und Aerodynamik," Band 4, 1 Teil p. 581 Akademische Verlagagesellshaft M.B.H. Leipzig (1931).

[13]Anderson, E. Western Precipitation Co., 1016 W. 9th St., Los Angeles, California.

The precipitator, a modified Cottrell[13] type working with 110 volts alternating current stepped up to 30,000 volts, collects weighable amounts of soot but also includes water vapor. The deposit caught on the asbestos filter in a Buchner funnel does not retain all the hydrocarbons given off by the heater but probably gives the most accurate results. Chemical analyses with and without ether extraction show the expected large variations in smoke character. The opaqueness of the smoke stream varies in its relation to chemically determined weight by +24 and —19 per cent. This is the limitation of the light interception method. It is readily explainable in that the interception must vary directly with particle number and size, but practically is unaffected by the weight of individual particles of soot which may have considerable absorbed liquid without appreciable change of dimension. However, a comparison of these three methods of measuring smoke indicates the probable limitation of each and thus makes it possible to attack confidently the elusive problem of smoke regulation.

Fig. 4 gives typical results as obtained with the present apparatus. The upper line shows that the burning rate, even when averaged over a period of 3 minutes, is rarely constant. This is due largely to the distillation cycle in the heater bowl, some heaters even showing regularly spaced smoke peaks. The bottom line is the record of opaqueness as observed each minute corrected only for temperature. The return to smokeless operation, when the draft was cut down after a high burning rate, shows the vital importance of air-fuel ratio. The middle line of smoke weight is derived from the other two using the rate of flow and calibration factor for weight. The 5-gram line reached by this particular heater represents the maximum for usually smokeless operation. Several other heaters, even more smoke free, are now available and will probably be the only types sold in the future.

The means for enforcing smoke abatement ordinances are the most difficult problem now as there are over a million short stack heaters in use which must be replaced, or new attachments provided to reduce their smoke output. Even some of the best heaters smoke outrageously if allowed to get dirty or pushed to a high-burning rate, so one cannot say that this or that type of heater is either good or bad. Therefore, it is evident that field test apparatus must be provided for measuring smoke output in the orchards. Fig. 5 shows the portable equipment used for extension demonstrations of heater operation throughout the citrus districts in November 1931. Smoke samples are collected by the precipitator or on felt. The felts give a vivid record of smokiness and can be graded photometrically. This equipment satisfied the supervisors of three southern counties as to method of field measurement and ordinances were passed to be effective March 1932.

Agriculture and the Depression[1]

By Walter E. Packard[2]

THE force of the position which agriculture holds in the general economic life of this industrial age, was brought home to me as the result of the preparation of a report on the economic feasibility of the Columbia Basin Project in eastern Washington. I am, therefore, going to use that project as an illustration.

As in most theoretical discussions, certain basic assumptions are made as a starting point. In the first part of this analysis it is assumed that the products from the million acres of land on the project will be absorbed by a growing market, at prices which will justify the estimated returns to the farmer. However, this assumption, which is based on a more or less standard forecast of population growth and future demand, is seriously questioned in the second part of the analysis which deals with buying power.

As indicated by Diagram No. 1, which shows the distribution of money received from the sale of crops, the ultimate consumer would pay $110,000,000 for the products of the project. Out of this, the farmer receives $51,824,000, or about 47 per cent of the total. Local manufacturers—creameries, canning establishments, meat packers, etc.—get $10,000,000, or approximately 9 per cent of the gross returns. Transportation agencies, merchandising interests, and outside manufacturers who use raw materials from the farms in their manufacturing processes, get $48,911,000, or about 44 per cent.

The farmer's return is spent in part for hardware and machinery, lumber and building materials, automotive equipment and supplies of all kinds. All of these are classed as retail items and total approximately $35,046,700. The balance of the farmer's fund, or $16,777,700, goes to general account, such as interest on borrowed money, cost of irrigation water, taxes and professional services, or, in general, to other than retail items. Some of the money which does not go directly into retail trade, however, appears in the total summation of retail trade for the community, since certain items, such as taxes, for example, go largely to the payment of wages and salaries, a large portion of which are spent in retail trade.

Analysis further shows that 60 per cent of the total money in circulation in the local community is made up of retail trade. Of this, 70 per cent comes directly from farmers' expenditures for retail items and approximately 15 per cent more from the farmers' general expenditures, which flow into the retail trade indirectly through payment of taxes or otherwise as previously explained. The balance of the money in circulation in the local community is made up of various items such as direct wholesale trade, interest on loans, payment for transportation and power services, and other items. Altogether the total local fund totals $83,277,700. This, it must be understood, is an annual sum which is wholly dependent upon farm production. It would disappear entirely if production should cease.

Approximately 25 per cent of the $83,277,700 remains in the community and operates as a revolving fund which passes through various hands and, in general, represents the price paid for the various services demanded by the community, including the farmer.

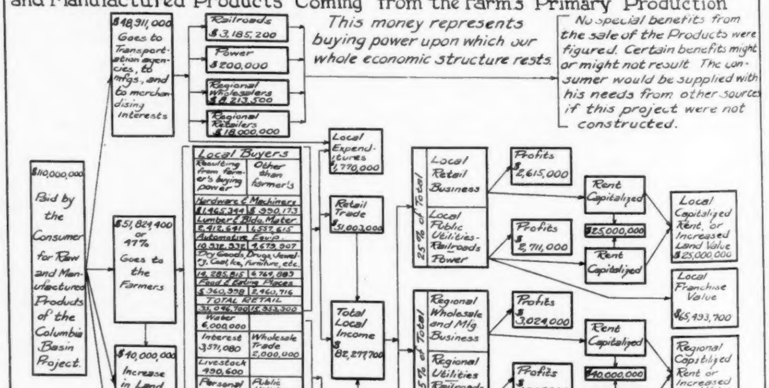
Of the $83,277,700, the sum of $62,000,000 goes to points outside of the local community. Regional centers get $37,377,000, which is distributed among manufacturers, wholesalers, investors, and public-utility interests. Approximately $24,000,000 goes to distant points—to Detroit for automobiles, to Moline for plows, or to Battle Creek for breakfast foods. The lump sums mentioned are, of course, broken down into smaller items, so that finally the money gets into the hands of consumers who have performed some service in the cycle of events, however remote, and whose purchasing power is thus maintained.

The $48,911,000 which is added to the cost of the product after it leaves the farm and which goes to the railroads, merchandising interests, and outside manufacturers using raw farm products, is spent quite largely in regional and distant centers. The only portion of this fund which appears in local trade is the money spent by local employees of railroads and wholesale interests.

The first important fact which appears in a consideration of this analysis of farm production is that development of this kind results in certain specific benefits. They can be grouped under three heads. The most important of these, from the standpoint of financing development, is the increment in values which results from the establishment of a new center of primary production. Farm land values, local and regional urban values, and power and railroad franchise values are all created by the establishment of new agricultural production and would disappear if that production stopped. This statement is, of course, based on the premise that there would be a satisfactory market for the products of the project.

In the case of the Columbia Basin Project, these increments in value would total $217,000,000. The increase in farm land value equals $40,000,000, or less than 20 per cent

DIAGRAM NO1. — The Distribution of Money Paid by the Consumer for the Raw and Manufactured Products Coming from the Farm's Primary Production



[1]A paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at Sacramento, Calif., January 1932.

[2]Consulting engineer, Menlo Park, Calif. Mem. A.S.A.E.

of the total. It is this item which usually represents the sole security behind irrigation district bonds, and it is not surprising, therefore, that the farmer who receives but one-fifth of the benefit, has difficulty in meeting the total cost of the development. The farmer, in fact, appears in a very unfavorable position throughout the analysis, for as a class he is damaged, and although he gets but 20 per cent of the values created, he is usually charged with the entire bill.

Local urban values are taxed in some districts in California and in certain other states. Where these urban values are taxed, they bear from 25 to 33 per cent of the operation and maintenance costs and interest charges of the districts, the approximate proportion which the increments in local urban land values bear to the total local values created.

A comparison of these increments in value with the costs of development offers a more or less accurate and reliable basis for determining economic feasibility. If the costs would be greater than the values created, the project would obviously be unsound. On the other hand, if the values created are greater than the costs, the project could be considered as basically sound. In the case of the Columbia Basin Project, the summation of values exceeds the costs by $35,000,000 or more.

A favorable balance, however, does not mean that the project is necessarily desirable. There may be other ways of using the money and manpower to better advantage or of getting equal benefits at less cost. This can be determined only by a comparison of various possible uses of the money and manpower.

A project may be considered economically feasible according to the standard set forth by this analysis, and it may also be desirable but still be financially unsound from a practical standpoint because of the difficulties of successfully assessing the benefits. In the past, projects have been approved for construction on the general theory that intangible benefits justify public subsidy. The least that can be said of this policy is that it is unscientific. The tremendous financial obligations involved in the high-cost projects which remain to be developed justify a change. No project should be approved in the future without a careful apportioning of benefits and costs.

As a result of the facts brought out by analysis of the increments in value, it was suggested in the report on this project that all interests in the Northwest should share in the costs of development, in proportion to their increment in values. Obviously, it is unjust to charge the farmer for the total cost of development on the basis of a possible increase in farm land values, for that increase would be but one-fifth of the total values created. The railroad interests should not object to the plan, for it is clearly shown by the analysis that the railroads could well afford to pay a part of the cost of the development in order to secure the permanent income which it would represent.

In future consideration of projects which may involve expenditure of public funds, the assessable and determinable increments in value received by specific interests should be assessed. This principle should form a part of a new reclamation policy.

The second class of benefits as shown by the analysis, is represented by the possible reduction in price of farm products to the consumer. In the state of Washington, for example, 85 per cent of the pork consumed is shipped in, the price being set by the cost of the marginal supply which comes from the Dakotas. As a result, the people of Washington pay the Dakota price plus freight. Seattle is the highest priced pork market in the United States, and has been for some years. If the Columbia Basin Project should produce enough pork to meet the demand of the Northwest, each consumer of pork would be benefitted through a reduction in price.

It is interesting to note that the only class damaged by this increased production, and decreased price, is the farmer. Increased production means increased competition, and might leave the farmer definitely worse off than before the development took place.

It is the business interests in the Northwest, not the farmers, who are urging Congress to provide money for the Columbia Basin Project. It is not increased production as such, in which the business interests are interested. It is the buying power which results from the production. Washington can continue to buy hogs from the Dakotas without any serious difficulty, but while they do the buying power which results from the production will remain in the Dakotas. If the Columbia Basin Project were established and proved successful, the land and franchise values which would result would be created in the Northwest, and the buying power represented by the money paid for hogs, for example, would be transferred from the Dakotas to Washington. The effect of development in the Northwest upon the Dakotas offers an interesting line of inquiry which cannot be presented here. Suffice it to say that it is the increased business and the increments in values resulting from expansion which prompt the support of the project by business interests, while it is the competition which the increased production makes for the farmer that has prompted the opposition of the Farmer's Union to the project. Both positions are logical and both are right when judged from the premises assumed in each case. It is obvious that the interests of both the producer and consumer should be considered in a proper balancing of the accounts.

The third class of benefits is represented by the opportunity for

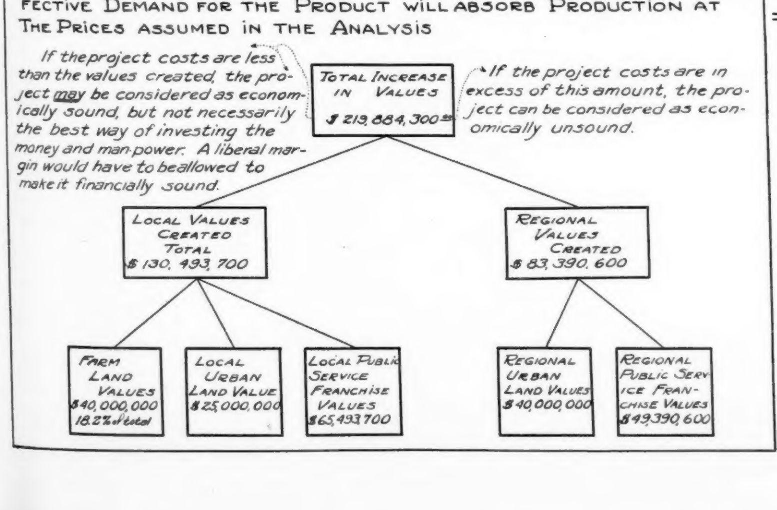


DIAGRAM 2

Distribution of Values Created By the Construction of the Columbia Basin Project at such time in the Future as Effective Demand for the Product will absorb Production at the Prices assumed in the Analysis

Diagrams 1 and 2 suggest a small part of the analysis of economic feasibility on which engineering development projects should be based

business expansion which the new development creates. Complicated ramifications of activity are set in motion. Farmers are occupied in production. Transportation agencies are busy carrying raw materials from the farm to the consumer and manufactured products back to the farmers. Factories are engaged in transforming the raw products into consumable goods and in supplying the needs of the new community. Merchandising interests are busy handling the flow of goods out of and into the project area. For the greater part of our history, the government has been interested in promoting this kind of expansion as a means of providing opportunity for a growing population. The Homestead Act and the land grants to the railroads have been the outstanding subsidies for expansion and have proved to be factors of tremendous importance in the conquest of the West. The creation of the federal reclamation service was but a continuation of the original policy of aiding in the development and occupation of the public domain. Territorial expansion has been a matter of national concern throughout history, since expansion is the easiest and most obvious means of promoting economic advancement.

The opening up of new land, however, immediately raises a problem of marketing the products. In our early history, before the days of farm machinery, the question of markets was not so serious as it is under present-day conditions. Production per man was low, as were farmer's requirements, and 80 per cent of the people were occupied in agriculture. At present, however, the problem of markets for farm produce is a most serious one. Production per man is high and his demands are correspondingly great. Even to buy the machinery which gives him his efficiency, the farmer must be able to sell his goods. In other words, there must be a widespread buying power and a capacity to consume, in order to maintain our present complicated but efficient producing machine.

Referring again to the Columbia Basin Project as a laboratory guide, certain pertinent facts present themselves. The million acres of land in the project would provide raw material to feed and clothe 250,000 people. The ramifications of operation and manufacturing activities which result directly or indirectly from this primary production on the project, would provide employment for 210,000 people, or 84 per cent of those who could be provided with food and clothing.

But permanent operation and maintenance do not represent all of the activities which would result. During the construction period, dams and canals must be built, land leveled, farm buildings erected, towns built, cities enlarged, transportation and communication facilities extended. Cement, steel, lumber, copper and other supplies would be needed and men would be employed in providing them. Construction equipment, farm machinery, automobiles and similar items would have to be supplied and labor used in the process. These expansion activities last only during the development period.

In other words, the expansion activities and the operation and maintenance activities together, would provide employment for as many people as the project would feed and clothe. So long as all the consumers were employed, there would be no overproduction, since the effective demand would consume all of the produce.

However, if the 16 per cent who were employed in expansion activities were not able to find employment in other expansion enterprises after the development work on the project had been completed, they would be out of work. As a result, they would have no buying power, and would be out of the market as normal consumers. Under such conditions, the project, considered as a dependent entity, would fail for lack of markets, unless some other group of consumers with buying power were discovered.

This brings us back to the original premise regarding a market for the products of the project. The market does not depend upon population growth alone. It rests in large part upon the buying power of that population. In the case of the Columbia Basin Project, a decision as to economic feasibility cannot be based on a forecast of population growth alone. Employment and buying power must be insured, for without them consumption cannot keep up with production. The logical conclusion is that the economic feasibility of the project, considered as an isolated unit, would depend upon the continued employment of those occupied in expansion activities. How does this appear when viewed from the standpoint of the nation?

The combination of circumstances which formed the foundation upon which our prosperity was built, has never been approached in past history and will never occur again. A relatively unoccupied continent of fertile lands, rich mines, and extensive forests offered its wealth to mankind at the very beginning of the industrial revolution. There was work to do, and all of those who were not employed in the permanent operation and maintenance activities of society, were occupied in expansion activities. The buying power thus established furnished a market for the products of industry. The consuming power of an occupied people absorbed the surplus of increasing production. This buying power is essential, if the wheels of industry are to be kept going. Without it the paradox of surplus and want, of wealth and poverty, will remain as foundations of unrest and revolt.

Optimistic as we may be, we cannot deny the fact that the great period of territorial expansion has passed. To those whose boyhood days were filled with dreams of Sitting Bull and Buffalo Bill, of the great roaming herds of buffalo that often blackened the plains as far as the eye could reach, of the covered wagon and the pony express, or of the first continental trains that connected the East and the West, this tremendous fact can hardly be realized. Yet it is true. A vast empire has been conquered and occupied by explorers, pioneers, and immigrants going west, ever west. The steel rails of the new era opened up a seemingly limitless territory where a wise and bounteous government was offering land to those who would occupy and cultivate it, in the great task of building a nation. The highway and automobile have but filled in the gaps in this greatest of migrations in all history.

This new land has provided homes for 124,000,000 people. Covering 986,771,111 acres of its land are 6,228,648 established farms. Its towns and cities number 2,707. They are connected by 260,000 miles of railways and more than 3,000,000 miles of roads.

This development can not be duplicated. Minor advances can be made in areas, through irrigation and drainage operations and by the development of foreign markets, but the era of great territorial expansion is at its close.

Expansion, however, is not limited to territorial growth by any means. Science and invention form a frontier which has greatly multiplied man's capacity to produce. Only one hundred years ago our forefathers were following the same farming methods that were in vogue in the time of the Pharaohs. No major progress had been made in four thousand years. Grain was cut with a scythe or sickle, hay was raked by hand, and land was cultivated with a hoe. The story of the progress which agriculture has made since 1831, when Cyrus McCormick invented the reaper, has often been told and need not be repeated here. Suffice it to say that the advance which has been made in agriculture has prepared the way for our twentieth century civilization. If it were not for the efficiency of agricultural production, 80 per cent of the population might still be occupied in agricultural pursuits as was the case one hundred years ago. Thanks to agricultural engineers, 25 per cent of the population can now produce enough to feed the nation. The balance of the population has been freed from the necessity of growing their own food and are available for the other activities which have been created by the growing complexities of our social and economic advance. But the very success of modern agriculture has created a new problem. How are we to keep the millions occupied who have been released from the soil? How is their buying power to be maintained under relative static conditions? This is the present challenge to the agricultural engineer.

Although it is obvious that we have reached the limit of easy territorial expansion, it would be absurd to suggest that we have reached the limit of expansion so far as science and inventions are concerned. But he would be sanguine indeed who would claim that we can look forward to discoveries in this or the next generation that will remotely rival in effect the influence of the discovery of the use of steam, electricity, and the internal-combustion engine; or the invention of the harvester, the steel plow, and the horse or power-drawn cultivator. Inventions which offer substitutes only, such, for example, as rayon for silk, plasterboard for wood, or tar paper for shingles, indicate scientific progress but do not have the same effect upon employment as the discovery of entirely new wants or the occupation of new lands. In fact, such discoveries may seriously upset the existing economic balance, as the dairyman who is competing with oleomargarine can well testify.

In spite of the temporary maladjustments due to certain types of invention, science and invention together represent our main frontier.

It seems obvious from this analysis that expansion activities, due both to territorial growth and to science and inventions, have been important factors in our economic progress. It is equally obvious that neither can contribute to employment in the future, to the degree that they have contributed in the past. This presents a fundamental problem which is apparently a major cause of general unemployment and depression. Palliatives and artificial stimulants will not remedy the situation. Our productive capacity has given us goods to consume, and is now providing leisure—a forced leisure—for consumption. We have not yet adjusted to the new situation. Our problem is one of buying power and consumption, rather than of production, and our attention should be directed along those lines.

It is apparent that agriculture holds a key position in the economic structure of the nation. If the farmer's buying power is curtailed either by overproduction or underconsumption, every line of activity in the country suffers. The farmer is injured, of course, but so are the merchants, bankers, clerks, railroad men, school teachers, and theaters —in fact, every activity in local, regional and distant centers is directly effected. There is no other industry which occupies the strategic position which agriculture holds. If the farmers are prosperous, the money they receive rolls back through a labyrinth of channels, keeping general industry going. When carefully analyzed, it is apparent that industry and business are largely occupied, directly and indirectly, in this cycle of activity from the farm to the consumer and back to the farmer.

When viewed in this light, overproduction assumes new importance, for overproduction cuts down the farmer's buying power with the long train of related events which follow. Whether the surplus is due to overproduction or to the loss in buying power resulting from the change from an era of expansion to more or less static conditions, the effect on business from the farm down is the same. For this reason, the construction of new projects during periods of maladjustments, whether caused by overproduction or underconsumption, may still further demoralize the economic balance. Buying power must be developed before, or concurrently with the development of new areas.

People who have accepted the apparent security of the past as a permanent heritage, have been buoyed up by the hope that history will repeat itself and that prosperity will return as it always has returned after past depressions. The constantly growing unemployment, the continued decline in the value of securities, and the tremendous loss in buying power of both labor and capital, however, is beginning to awaken the American people to a realization that something fundamental has happened. Some are beginning to feel that recovery is not a matter of weeks or of months, or perhaps even of years, but it rests upon a long-time adjustment of our social organization to the requirements of a new set of conditions.

Many almost hysterical attempts have been made to apply external remedies to basic maladjustments, by applying crutches to agriculture and industry in the form of enormous appropriations to stabilize prices, or to provide credit for more installment buying. But remedies of this kind do not reach the source of the trouble. Public works may extend the benefits of expansion activity, but there comes an end to the possibility of artificial stimulation and a pay day which can not be indefinitely postponed. The problem is a fundamental one, and it can only be solved by fundamental remedies. We as a nation do not begin to understand the problem. Our minds have been trained on problems of production and we are bewildered by the new conditions.

In order to be as specific as possible, I am going to offer certain planks for a platform for agricultural engineers. Among these planks I would place first the continued promotion of science and invention, to extend the benefits of an expanding period. As a second, I would suggest shorter working hours and shorter working weeks in all occupations. More leisure on the part of those employed, and therefore more time and desire to consume; and less leisure for those who are now unemployed would so stimulate trade that a high standard of wages could be paid for the shorter period of employment. The increased buying power and leisure to consume, which such a program would create, would do more than any other single act to relieve this depression. Measures of this kind are imperative. We have the productive capacity and are in a position which offers greater opportunity for general contentment and well-being than the world has yet seen. A proper distribution and use of the leisure which our efficiency has produced, is essential to our prosperity.

A third plank would be a radical modification of our tariff walls to permit international trade on a basis which economic conditions justify. Artificial tampering with the normal flow of trade by price-fixing or tariff walls is sure to result unfavorably in the long run.

The fourth plank in the platform would be in support of cooperative marketing as a means of eliminating duplication and waste, and of adjusting production to consumption.

The fifth plank would call for a more conservative program of agricultural expansion. New irrigation and drainage projects should not be urged until the more fundamental problems of consumption are solved, for without widespread employment and the resulting buying power, production will continue to outstrip consumption. Large projects, requiring decades for completion, could be started by having the preliminary foundation work in soil classification, engineering, etc., carefully worked out in preparation for construction when the right time arrives.

This plank would include a modification of our reclamation policy to establish a sounder basis for financing those developments which affect varied interests, and create varied values, but which in the past have been built upon the credit of but one part of the whole. Costs of development should be borne in proportion to the benefits received and approval of projects should rest upon a scientific analysis of economic feasibility.

The sixth and last plank would deal with the distribution of wealth. Increments in land and franchise values, private ownership of natural resources, and the tremendous economies which have been possible in the growing stages of industries, have resulted in the concentration of wealth in the hands of a relatively few. These few have a limited capacity to consume, and therefore must invest their wealth in capital goods, in machines and tools. During periods of expansion it is wise to have wealth thus concentrated, but under more static conditions, it places an overemphasis on production at a time when consumption should assume the dominant position. Widespread ownership in stocks, relatively high wages, income and inheritance taxation, and conservation of natural resources are parts of the program and should be included in this plank in the platform.

We are facing the most interesting period in history. The future can unfold an economic well-being far beyond the records of the past. What part will the agricultural engineer play in this new drama of life?

Heating Water by Solar Energy[1]

By Arvy Carnes[2]

FOR a number of years members of the staff of the astrophysical observatory of the Smithsonian Institution have been determining the amount of solar radiation reaching the earth. Dr. C. G. Abbott who has been directing this work designed and operated a solar cooker. Frank Shuman, of Philadelphia, Pennsylvania, designed a solar steam plant that pumped water for irrigation purposes in the Nile Valley; the boilers were placed at the focal center of large parabolic mirrors which were rotated with the sun. A solar heater, designed to furnish hot water for the household, was put in operation by a company in California several years ago. Since work was started on solar heating at the Alabama Polytechnic Institute, a company in Florida put on the market a solar heater that furnishes hot water continuously, and which works in conjunction with a low-wattage electric heater.

An investigation[3] of the use of solar energy for heating water for the household or dairy was started at the Alabama Polytechnic Institute in June 1925. The object was to determine the value of solar energy as a supplement to electric energy for heating. Various experimental designs of solar heaters were studied in connection with the college dairy and homes in the neighborhood. Factors affecting design were studied independently of each other with laboratory apparatus. From these studies, these factors were evaluated and made the basis of an approximate design formula.

AVAILABLE SUNSHINE

Studies were made of the U. S. Weather Bureau records to determine the availability of sunshine in the various months of the year. Records of the available sunshine in Alabama are shown in Table I.

In Alabama there is an average of 241 h of sunshine per month for nine months of the year (March to November, inclusive), or an average of 7.9 h per day, that can be utilized by a solar heater. For the other three months the average is only 146 h per month, or 4.8 h per day. During December, January, and February it is not advisable to depend on a solar heater to furnish hot water for household purposes, but in most homes some heating apparatus is being operated during these months which may be used for heating water.

HEAT VALUE OF SUNSHINE

Even with bright sunshine there is a considerable variation in the amount of heat energy received at the surface of the earth from the sun from day to day. In the solar heaters tested, within one hour, a variation in heat absorption of 50 per cent, caused by a slight haze, was recorded. The variation is largely due to changes in the clearness of the atmosphere, that is, its freedom from water vapor, dust particles, and smoke. The actual amount of heat received from the sun is usually expressed as a constant.

The solar constant K[4] is usually evaluated by giving the quantity of heat, in small calories received from the sun, at its mean distance from the earth, in one minute by one square centimeter of a perfect absorbing surface presented at right angles to the sun's rays. Different investigators do not agree on the value of K. Table II shows some values obtained. C. G. Abbott's value ($K = 1.94$ cal per sq cm per min) is considered most accurate. Since the calorie is such a small unit of heat, we will consider the solar radiation roughly as 5 Btu per sq ft per min.

HOUSEHOLD REQUIREMENTS FOR HOT WATER

A supply of warm or hot water varying in temperature from 97 to 160 deg (F) is needed in the household and in dairy plants. The average daily consumption of hot water for a family of three is 29.3 gal, and for a family of five, 49 gal. The greatest water consumption is at night. This favors the use of the solar heater.

SOLAR HEATER EQUIPMENT

The main parts of a solar heater are the absorber, the absorber box, the storage tank, and necessary connections. When forced circulation is desired, a circulating pump is necessary.

The heart of the solar heater is the absorber. Its function is to absorb the solar energy and transmit it, in the form of heat, to the water. Its efficiency in accomplishing this is determined, to a large extent, by the heat gradient or difference between the water temperature and the metal temperature at the surface exposed to the sun.

The surface of the absorber should be placed so that the sun's rays strike at an angle of 90 deg. An angle of 46 deg with the horizontal at a latitude the same as Montgomery, Alabama, will give best results.

It would be difficult and expensive to construct an absorber that would store enough heat within itself to heat 8 or 10 gal of water from 75 to 130 deg, and the radiation losses would be excessive.

ABSORBER DESIGN FACTORS

Type of Fin. A fin is a metal strip attached to a surface of a tube to increase the surface for absorption or radiation. When the temperature in the tube is lower than that in the outer edge of the fin, heat will flow to the tube, resulting in absorption. In this investigation fins were used to increase the absorption surface of the pipes.

To determine the value of fins for this purpose, rectangular tubes with various widths of fins were constructed of 28-gage galvanized sheet steel. Dimensions of the tubes were constant but the widths of the fins varied. The tubes were placed in the sun under glass, and water at a constant temperature forced through them. The rate of flow was varied and the increase in temperature noted at the outlet. This gave a basis for calculating the absorption per unit area. A fin 1.27 cm wide gave the limit of high

[1]General summary of a study of experimental designs of solar heaters at the Alabama Agricultural Experiment Station. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Assistant professor of agricultural engineering, Alabama Polytechnic Institute. Assoc. Mem. A.S.A.E.

[3]Investigation conducted under funds provided for this purpose by the Alabama Power Company.

[4]Letter K used as a symbol for the heat equivalent of sunlight per unit area in unit time.

Table I. Hours of Sunshine by Months for Several Localities in Alabama

Locality	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Birmingham	147	158	208	218	227	263	247	251	237	226	202	132
Anniston	127	139	178	218	266	266	262	240	235	223	173	128
Montgomery	156	170	222	257	313	313	272	273	242	230	211	137
Mobile	159	173	226	285	304	219	254	253	235	237	205	143

Table II. Value of Solar Constant as Determined by Various Investigators

Observer	K (cal/sq cm/min)	Place
Langley	3.0	Top of Mt. Whitney
Viole	2.5	Top of Mt. Blanc
Savelief	3.4	Kief (Ground covered with snow)
Angstrom	4.0	Ixele
C. G. Abbott	1.94	Numerous places

efficiency transfer of heat under the conditions of the test. Since the initial temperature of the water was held at 94 deg, a small heat gradient existed. This temperature was the mean of tap water temperature and stored water temperature desired. With a greater heat gradient, a wider fin would have shown a greater absorption.

The width of fins to be used on a solar absorber depends on the conductivity of the metal used, its thickness, and the heat gradient to be maintained. Rolled copper has a conductivity double that of the material used in the fin test.

Depth of Water Under Absorption Surface. Water flowing through pipes or tubes at certain velocities will produce stream-line flow. For a given size of pipe, there is a velocity of flow beyond which turbulent flow is produced. Turbulent flow is desirable in solar heating since most of the water in turbulent flow will come in contact with the inside pipe surface and absorb the heat. If stream-line flow is set up, the water will pass through the pipe without coming in contact with its inside surface and absorption would have to take place by conduction through the water. Conduction of heat from one layer of water to another layer is slow. The rate of absorption depends on conductivity and thickness of metal in the absorbing surface, heat gradient, and stream-line and turbulent flow.

Method of Circulation. The heated water may be conveyed to the storage tank by thermosiphon action or forced with a circulating pump. If storage is to be accomplished by thermosiphon action, the storage tank must be placed at least one foot above the absorber. This would not permit using the storage tank already in operation to store the hot water from the range or coal stove. It would be necessary to place a second storage tank in the attic. If a circulating pump is placed in the pipe line between the absorber and storage tank, the storage tank may be located in the basement or any convenient place. In this case only one hot water tank is necessary.

Kind of Paint. Various commercial paints were tested for their heat absorption qualities. It was found that the surface of the absorber should be covered with a thin, dull-black coat of paint to get the maximum absorption of heat and light rays. A paint made of lampblack, asphalt paint, turpentine, and gasoline, gave the best results of those tested. The gasoline was used to cut the lampblack and asphalt paint so as to produce a thin coating. Just enough turpentine and lampblack were added to prevent a gloss.

Table III. Temperature Rises and Heat Absorption Obtained with the Recirculation Solar Heater

Date	Position in tank	Temperatures at various times of day, deg F				Rate of heat absorption, Btu/sq ft/min
		10:15	11:00	11:45	12:30	
October 7	Top	62	88	94	114	
	Bottom	62	72	86	99	2.74
October 8	Top	62	103	117	122	
	Bottom	62	88	104	116	3.63
October 11	Top	64	92	106	112	
	Bottom	64	73	92	104	2.93
October 13	Top	62	98	100	115	
	Bottom	62	73	86	110	3.22
October 14	Top	62	99	112	118	
	Bottom	62	78	97	108	3.25
October 15	Top	62	90	106	112	
	Bottom	62	64	88	104	2.93
October 16	Top	62	95	107	116	
	Bottom	62	66	90	100	2.93
October 17	Top	62	95	105	114	
	Bottom	62	68	98	102	2.93
October 18	Top	62	97	109	118	
	Bottom	62	68	97	109	3.28
Mean Temperature		62	84	100	111	
Mean Btu/sq-ft/min			4.2	3.63	3.12	3.09

TESTS OF ABSORBERS

Several designs of solar heaters were constructed and tested. One was made of 2-in pipes fitted into 4 by 4 by 2-in Ts. The 4-in Ts were connected with jam nipples forming a header at each end of the 2-in pipes. A similar one used 3/16-in tubes connected as described above except that ¾-in pipe was used for the headers. The second design gave slightly better results due to more efficient use of the absorption space under the glass. A third design employed 28-gage corrugated sheet roofing riveted on 24-gage flat steel, with the ends soldered into 2-in lead pipe headers. This design gave much better results due to utilizing the entire surface under the glass to absorb the solar energy. This solar heater was tested throughout one year and supplied hot water for washing purposes and to preheat water for an electric sterilizer in a twenty-cow dairy. Fig. 1 shows the average temperature rises for the months and hours indicated. This absorber had an area of 45 sq ft and was connected to an 86-gal storage tank.

Circulation, in the three designs described above, was accomplished by means of thermosiphon action. It was concluded that this caused the absorber to operate with a narrow heat gradient and low efficiency.

Mechanical circulation through the absorber of the fourth design was incorporated to maintain a wide heat gradient. Essentially, the fourth design embodied ¼-in copper tubing soldered in the valleys of corrugated steel roofing and connected in parallel to headers of ¼-in copper tubing as shown in Fig. 2. It was necessary to solder the tubing to the corrugated steel to facilitate heat transfer from the steel to the tube. The ⅜-in pipe, AB, connected the top edge of the solar heater and the top of the 30-gal basement hot water storage tank, T. The ⅜-in pipe, CE, connected the bottom of the storage tank to the lower edge of the absorber. The city water was connected at G. A centrifugal pump with a 1/6-hp motor was placed in the line CE. One recording thermometer lead was placed in the top and the other in the bottom of the storage tank.

This absorber had an area of 30 sq ft and was placed on a porch roof. It has been in operation for two years, furnishing hot water for a family of five.

The solar heater can be made automatic by placing a thermostat in the upper edge of the absorber and connecting it through a relay to a motor-operated switch. The thermostat can be set at the desired temperature and when the water in the absorber gets to that temperature the circulation pump is put in operation through the motor operated switch and transfers the hot water to the storage tank.

Data obtained with this design are shown in Table III. The centrifugal pump was started at 10:15 a m and cut off at 12:30 p m. It took 45 min to circulate 30 gal of water through the absorber. Fig. 3 is a straight line showing the Btu absorbed per square foot per minute. A nine-day average showed a temperature of 111 deg for the 30-gal tank. Taking 5 Btu as the solar radiation per square foot per

Table IV. Relation of Capacity of Storage Tank to Absorber Area and Temperature Rise

Capacity of storage tank in gal	Temperature rise deg F	Absorber area in sq ft
30	40	30
30	55	35
30	65	42
30	75	48
40	40	40
40	55	45
40	65	52
40	75	63
60	40	60
60	55	68
60	65	78
60	75	95

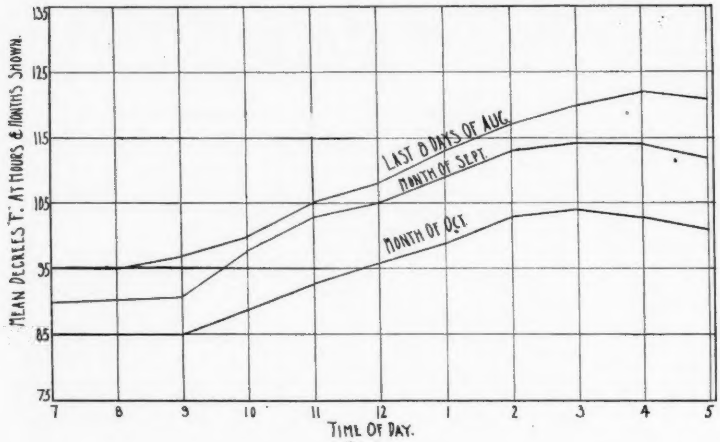


Fig. 1.

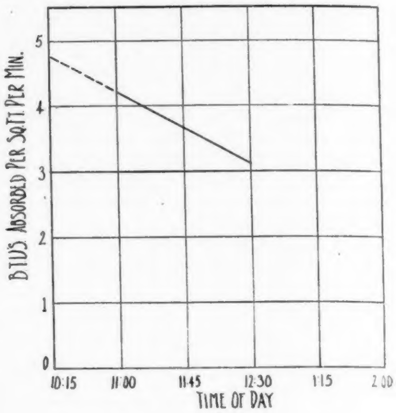
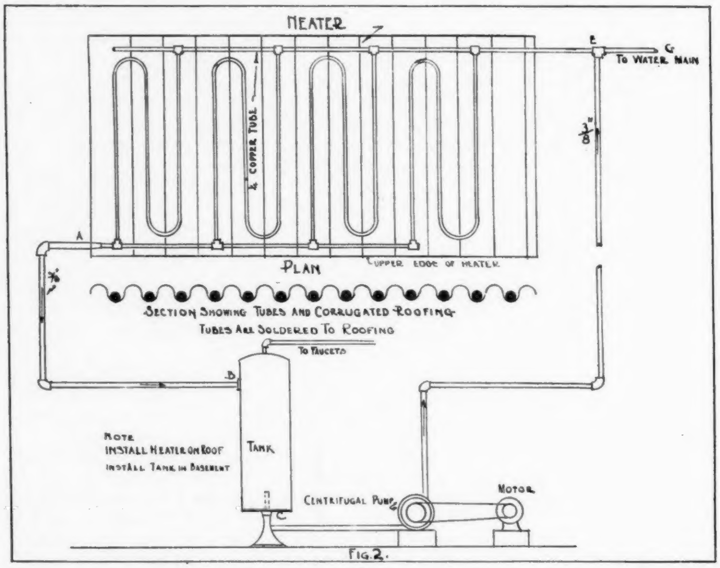


Fig. 3.



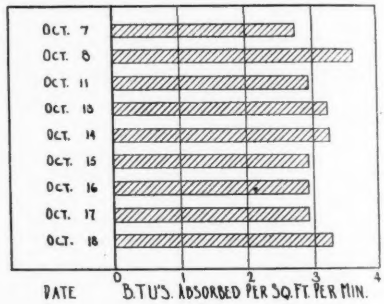


Fig. 4.

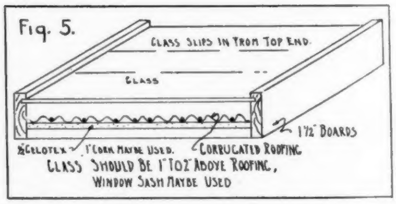


Fig. 1. Average rise of water temperatures for the periods indicated, produced by the third solar heater design, with 45 sq ft of absorber area, thermosiphon circulation and an 86-gal storage tank. Fig. 2. General plan and circulation diagram for the fourth solar heater design. Fig. 3. Heat units (Btu) absorbed per square foot per minute by the fourth design, as influenced by heat gradient. Fig. 4. Average heat absorption in Btu per square foot per minute, for the fourth design, on each of the nine test days. Fig. 5. Construction of the absorber box for the fourth design

min, the first 45 min showed an efficiency of 84 per cent, the second 45-min period, 72.6 per cent, and the third 45-min period, 62.4 per cent. During the nine-day test the efficiency did not fall below 58 per cent on any one day.

Fig. 4 shows the Btu absorbed per square foot per minute on each of the nine days the test was run.

FORMULA TO DETERMINE SIZE OF ABSORBER

From the data shown in Table III an approximate formula for the design of a solar heater has been derived. It can be used to determine the third of the three variables, absorber surface area, size of storage tank, and temperature rise, when any two of the variables are known.

$$Q = CAT \div d$$

where Q = amount of heat in Btu in the storage tank water

A = effective area of the absorber in square feet, depending on conductivity and thickness of fins

d = thickness in inches of the pipes in the absorber

C = an approximate constant to take care of radiation losses

T = temperature rise of water in the storage tank

From the data shown in Table III (October 7) the average total rise in temperature $T = 44.5$ deg. The total number of heat units, Q, stored in the storage tank was 11320 Btu for the 2 hr 15 min the solar heater was operated. The thickness, d, of the copper tubing = 3/64 in. $C = 0.8$. From the data on fins the effective absorption area, $A = 15$ sq ft. The accuracy of this formula can be shown by substituting these values in the equation, $Q = CAT \div d$

$$11320 = \frac{.8 \times 15 \times 44.5}{3/64} = 11368 \text{ Btu}$$

$$11392 - 11320 = 72 \text{ Btu error}$$

$$\frac{72}{11320} \times 100 = 0.64 \text{ per cent error in the formula}$$

From the data on fins, only 50 per cent of the absorber surface under the glass was effectively utilized in absorbing the solar heat. Hence, in using this formula to calcu-

late the size of the absorber, the result should be multiplied by two.

As stated previously, C is used as an approximate constant. As the temperature of the water is raised, the value of C decreases. In the type of solar heater studied here, for a temperature up to 110 deg, $C = 0.8$; from 110 to 125 deg, $C = 0.7$; from 125 to 140 deg, $C = 0.6$; from 140 to 155 deg, $C = 0.5$. The value of C depends on the temperature gradient between the water in the storage tank and the surrounding atmosphere, and, to some extent, on the insulation of the storage tank and the connecting pipes.

Table IV shows the relation of the number of square feet of absorber space to the temperature rise and size of the storage tank. These figures were obtained by applying the formula previously described. The formula is based on the recirculation type of solar heater in which the entire volume of water stored in the storage tank is circulated through the absorber in 45 min.

ACCESSORY EQUIPMENT

Box to House Absorber. The absorber must be housed in a tight, glass-covered, insulated box to cut down convection and radiation losses. The glass cover serves as a trap for the solar energy and prevents rain water from coming in contact with the absorber. The absorber box should be insulated on the inside with cork board, or ½-in insulating board. Fig. 5 shows the details of construction of the absorber box.

Storage Tank. A satisfactory way to insulate the storage tank is to construct, out of tongue-and-grooved flooring, a box 8 to 12 in larger in diameter than the storage tank; place the tank in the center of the box, and fill around the tank with powdered cork or dry sawdust. This will give from 4 to 6 in of insulating material which will materially cut down radiation losses.

Connections and Circulation Methods. If thermosiphon action is to be used, the connecting pipes should be ¾-in or larger, and all pipes should be laid to prevent pockets. If forced circulation is used, the connecting pipes may be smaller. In either case all connecting pipes should be insulated. A satisfactory method of insulating the pipes is to wrap two or three layers of heavy paper around the pipe and cover with an asphalt base paint.

COST OF SOLAR HEATER

A solar heater like that shown in Fig. 2 can be constructed and installed for approximately \$55.00. The materials and labor for constructing it will cost approximately \$45 and \$10 would be a liberal allowance for installing.

CONCLUSIONS

1. The solar heater seems to offer a practical means of supplying hot water for household and dairy purposes. For continuous service it should have an auxiliary electric, oil, or gas heater.
2. Under favorable conditions it is possible to store from 58 to 84 per cent of the available solar energy.
3. The storage tank and absorber box should be well insulated against heat loss. The absorber should be covered with glass.
4. The inside of the absorber box and the surface of the absorber should be painted a dull black.
5. The absorber should be set at an angle of 46 deg with the horizontal in a latitude the same as Montgomery, Alabama.
6. A circulating pump placed between the storage tank and the absorber increases the heat gradient, which increases the rate of absorption.
7. A solar absorber constructed by soldering copper tubing in the valleys of corrugated roofing gave the best results of the absorbers tested.
8. When absorbers are constructed of pipe, fins up to a certain width will add to the rate of absorption. When fins are made of 28-gage sheet steel they should be ½ in wide.
9. To furnish hot water for a family of five, it will cost approximately \$55.00 to construct and install a solar heater.

Bibliography

1. Abbott, C. G. Annals of the Astrophysical Observatory of the Smithsonian Institution. Volume IV, 1922
2. Kimball, H. H. Records of Total Solar Radiation Intensity and their Relation to Daylight Intensity. Trans. I. E. S. May 1925
3. Hobbie, E. H. and Little, W. F. Transmission of Light through Window Glass. Trans. I. E. S. March 1927
4. Burns, G. R. A Portable Instrument for Measuring Solar Radiation in Forests. Vermont Agri. Expr. Sta. Bulletin 261, 1927
5. Kloeffler, R. G. Water Heating in the Home. Kansas State Agri. College Bulletin 11, 1921.

The Relation of Consumption, Production and Distribution[1]

AN AMERICAN ENGINEERING COUNCIL committee is studying the above subject, with a view to minimizing economic depressions, from the long-time standpoint of balancing economic forces by

1. Maintaining or increasing the consumption of goods and services
2. Balancing of plant, machinery, and processes against production demands
3. Balancing of distribution agencies against consumer requirements
4. Balancing of manpower against production and distribution demands
5. Controlling of money and credit to satisfy the needs of government, business, and individuals
6. Encouragement of research activity — to increase human well-being through development and progress in industry and business
7. Balancing of public works against public needs
8. Balancing of agricultural supply with effective demands.

It points out that point 8 is involved in all the others and demands particular study.

[1]Abstract of a progress report of the Committee on the Relation of Consumption, Production and Distribution, American Engineering Council.

The committee has further interpreted its commission as being the selection and recommendation of such governmental, financial and business policies as will maintain in the United States a standard of living that is high, broadly distributed, and free from severe fluctuations.

Contrary to much present-day thought on economic matters, the committee believes that the principles and methods of modern technology are as applicable to the control of economic as to physical and other natural forces. It also believes that the development and economic independence of the United States are such that it can rise above world conditions.

In attempting to explain the present economic situation, as a basis for a working hypothesis, popular explanations are classed as questionable and/or inadequate as follows:

1. Technological unemployment — not supported by U. S. Department of Commerce and other figures on employment up to the point of recession in 1929.

2. Wasteful manufacture and distribution — serious but not a primary cause; tends to counteract the severity of technological unemployment; should be eliminated as far as possible but could not be used as a direct means for controlling the business cycle.

3. General overproduction — non-existent from the

standpoint of physical possibilities for increasing consumption.

4. Speculation — not a primary cause but a psychological force aggravating, exaggerating, and extending conditions of unbalance; open investment market needs internal reform.

5. Installment buying — aggravating factor which masked the failure of buying-power to keep pace with production; a valuable means of extending consumer credit in appropriate degree at the proper time in the business cycle.

6. Breakdown of international trade and credit — a disturbing element but not an insuperable barrier to recovery in the United States.

The Committee's own summarized explanation is that the depression which began in 1929 seems to be the recession phase of a typical business cycle occurring coincidently with a typical post-war deflation, and aggravated by a unique agricultural distress and a slackening of the opportunities for investment at a profit.

Failure of purchasing power to keep in balance with production, due to withdrawal of funds from purchasing power by saving and shortage of opportunities for new investment is the cumulative internal weakness which sooner or later brings the business cycle to its downward phase. This is the engineers' pick of the assortment of economists' explanations of the phenomenon. Recovery requires the dissipation of this condition by the exhaustion of uninvested savings, the writing-off of bad debts, borrowing money on life insurance, etc., until a lack of goods becomes evident and purchasing power again exceeds current production.

Post-war deflation is a part of the misery and injustice of war, especially serious in the present situation because of the improbability of such additions to the gold supply as relieved the deflations subsequent to the War of 1812 and the Civil War. It is inevitable following inflation, but possibly subject to some control.

The agricultural distress is a combined result of post-war deflation, increased world competition, technological progress resulting in increased production, and decreased per capita consumption of some commodities. Decreased agricultural purchasing power, in turn, is a depressing influence on all business.

Slackening opportunities for profitable investment, due to passing of the stage of rapid mechanization of society, is an effective factor in the present situation and will have to be reckoned with in the future, but may be minimized by lowering interest rates which in turn would broaden the field for profitable investment.

Suggested lines of action are not based on discarding the present economic system based on individual initiative, competition, and profit in favor of any form of arbitrary control or complete economic planning. They are based on a hope of modifying the present system with controls which will not require "beyond-human" knowledge or skill in planning; which will employ the forces and desires of human nature as it is, by direction rather than by compulsion.

Specific suggestions in regard to the immediate problem of balancing the rate of saving with the rate of investment include long-time budgeting for government as well as business, on the belief that in the course of a business cycle there is a time to tax and a time to relieve taxation; a time to borrow and a time to repay, a time to expand money and a time to contract it, a time to extend public works operations and a time to contract them. Another instrument of control toward the same end is the balance of international payments.

Further specific suggestions urge the continued decentralization of manufacturing for the sake of human as well as business values; development of trade associations, including the collection and frequent publication of basic information on their industries; and development of a country-wide, thoroughly coordinated, efficiently-staffed system of employment agencies, considered essential to any plan of controlling economic forces.

Studies are strongly recommended of the possibilities of effecting additional controls by the stabilization of money, or general price levels; by industrial insurance and pension plans; and by shortening of the work week. A further suggestion, conditioned by some doubt as to whether this country is in fact nearing a saturation point in mechanized equipment, is a search for new profitable investment possibilities. In this connection it is suggested that banks might profitably maintain engineering staffs to search out investment opportunities as aggressively as their sales departments seek to enlarge their lists of depositors.

Agriculture the committee handles gently and with gloves, granting that inflation of the industry was urged by the country as a whole, that it is the first and most long-suffering victim of deflation, that it possesses no inherent self-protection, and that they have no specific suggestions for improving its condition, beyond those made for business in general. Caution in the execution of the government reclamation policy is advocated.

The one negative recommendation of the committee strongly condemns production by agreement to reduce output, or allocation of business, as leading to stringent government regulation and official price fixing.

Classing the relation of consumption, production and distribution as of such importance that no human problem compares with it in difficulty, in magnitude, in hopefulness, the report concludes with a warning that it is only the basis for more detailed and exhaustive consideration, and a challenge to "the highest human capacities of our time."

(EDITOR'S NOTE: Individual copies of this report, in full, may be obtained by writing American Engineering Council, 744 Jackson Place, N.W., Washington, D. C.)

The social and economic significance of this type of machinery is as much an engineering problem as its mechanical construction, production, and operation

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

The High-Speed Internal-Combustion Engine, H. R. Ricardo (London: Blackie & Son, 1931, pp. [7] + 435, figs. 292).—This is a revised and enlarged edition of the second volume of a book published in 1923 and entitled "The Internal-Combustion Engine."

It contains chapters on volatile liquid fuel for internal-combustion engines, detonation, distribution of heat in a high-speed four-cycle engine, influence of form of combustion chamber, lubrication and bearing wear, mechanical design, mechanical details, valves and valve gear, piston design, engines for road vehicles, aero engines, high-speed heavy-duty engines for tanks, and high-speed Diesel engines.

Report of Proceedings of the Second Southwest Soil and Water Conservation Conference (Oklahoma Station (Stillwater) Circular 19 (1931), pp. 94).—The text of the proceedings is presented. These include among other things special papers on Research Program of Soil Erosion in Oklahoma, by C. P. Blackwell of the Oklahoma Experiment Station (pp. 8, 9); The Oklahoma Soil Erosion Survey, by N. E. Winters of the Oklahoma Experiment Station (pp. 9, 10); The Soil Conservation Research Program for the Southwest, by A. G. McCall of the U.S.D.A. Bureau of Chemistry and Soils (pp. 11-15); Experimental Work on Soil Erosion and Water Control in Texas, by R. E. Dickson of the Texas Experiment Station (pp. 16, 17); Experimental Work in Kansas, by F. L. Duley of the Kansas Experiment Station (pp. 19-21); Soil Erosion in Western Mississippi, by G. H. Lentz of the U.S.D.A. Southern Forest Experiment Station (pp. 23-31); There Can Be Too Little Erosion, by M. F. Miller of the Missouri Experiment Station (pp. 32-35); Study of Runoff from Terraced Fields, by R. W. Baird of the Oklahoma Experiment Station (pp. 36-38); Soil Erosion Work of the Bureau of Chemistry and Soils at Guthrie, Oklahoma, by S. W. Phillips of that bureau (pp. 40-45); Results of Experiments on Erosion Control on the Guthrie Soil Erosion Experimental Farm, by C. E. Ramser of the U.S.D.A. Bureau of Agricultural Engineering (pp. 46-53); Handling Runoff from Terraced Fields, by L. E. Hazen of the Oklahoma Experiment Station (pp. 55-57); Report on Protecting Road and Hillside Ditches with Concrete Baffles, by W. H. McPheeters (pp. 57-61); and Soil Erosion, by H. H. Bennett of the U.S.D.A. Bureau of Chemistry and Soils (pp. 62-69).

Humidification for Residences, A. P. Kratz (Illinois University, Engineering Experiment Station (Urbana) Bulletin 230 (1931), pp. 30, figs. 10).—This bulletin brings together certain useful information on the subject from various sources and presents the results of laboratory experiments.

It has been found that optimum comfort is the most tangible criterion for determining the air conditions within a residence. An effective temperature of 65 F represents the optimum comfort for the majority of people. Under the conditions in the average residence a dry-bulb temperature of 69.5 with relative humidity of 40 per cent is the most practical for the attainment of 65.

Evaporation requirements to maintain a relative humidity of 40 per cent in zero weather depend on the amount of air in leakage to the average residence, and vary from practically nothing to 24 gallons of water per 24 hours. Relative humidity of 40 per cent indoors can not be maintained in rigorous climates without excessive condensation on the windows unless tight fitting storm sash or the equivalent are installed. The problems of humidity requirements and limitations can not be separated from considerations of good building construction, and the latter should receive serious attention in the installation of humidifying apparatus.

The experimental results showed that none of the types of warm-air furnace water pans tested proved adequate to evaporate sufficient water to maintain 40 per cent relative humidity in the research residence except in moderately cold weather. The water pans used in radiator shields tested would not prove adequate to maintain 40 per cent relative humidity in a residence similar to the research residence when the outdoor temperature approximates zero F.

Appendixes deal with the measurement of relative humidity and with a method of calculation for curves of humidity requirements and limitations.

Effect of Variable Compression Ratio on the Performance of Tractor Engine Using Alcohol, A. L. Teodoro (University of Philippines (Los Banos) Natural and Applied Science Bulletin, 1 (1931), No. 3, pp. 187-221, figs. 12).—Studies conducted at Cornell University on the effect of compression ratio on the suitability of alcohol as a fuel for a 10 to 20-horsepower tractor engine are reported. Straight alcohol of different strengths, denatured alcohol, gasoline and kerosene were used in the studies. The compression ratios tested were 4.28 : 1, 5.03 : 1 and 6.43 : 1. A hydraulic dynamometer was used which was capable of absorbing a maximum of 150 horsepower at from 1,200 to 4,000 revolutions per minute.

Sixty-seven tests, each of at least 30 minutes duration, showed that the engine could be run on alcohol at loads varying from a little over 1 horsepower to a little more than 25 horsepower. The only change necessary to permit running the engine on alcohol was an enlargement of the fuel passage to supply a sufficient quantity of fuel. Without changing the size of the carburetor jet provided for the use of kerosene, the maximum power developed using alcohol was less than the rated capacity.

Tests were conducted with the area of the fuel passages about one and a half times as great as the area provided for kerosene. Under this condition, a maximum load of only a little over 50 per cent of the normal rating was attainable and the air choke had to be closed almost one-half. When two holes were used, having a total area of more than twice the area provided for kerosene, a load higher than the normal rated capacity was developed with the choke wide open.

With the carburetor adjusted to supply enough fuel to make the engine carry an overload of 10 per cent of the normal rating, the load could be quickly varied. Only the noise of the motor exhaust markedly showed that something had been changed. In general, except where the mixture was too lean, the engine operated more smoothly and ran with a lower radiator temperature when using alcohol than when using either kerosene or gasoline at any load. This was observed especially at points starting from three-quarters load to normal.

With alcohol, gasoline and kerosene, the fuel consumption per brake-horsepower-hour for a given compression ratio depended not only upon the per cent load but also upon the setting of the fuel needle valve. The most economical points for both gasoline and kerosene appeared to be between three-quarters load and the normal load, at a compression ratio of 4.28. In the case of alcohol, however, the point of greatest economy was either at full load or at the point where the engine developed the maximum power. At three-quarters load approximately 15 per cent more fuel than the requirement for the normal load was consumed by the engine when alcohol fuel was used, at half load 150 per cent more. In the case of kerosene and gasoline, however, the per cents of fuel used in terms of the normal requirement were from 110 to 120 at half load, and about 200 at quarter load. With a compression ratio of 4.28, the equivalent amount of alcohol fuel used in terms of gasoline was about 1.32 at normal load. The tests showed that, in general, the maximum power that the engine developed was usually higher using alcohol fuel than when using either gasoline or kerosene.

The most marked effect found with a change in the compression was in the fuel consumption and in the maximum power developed. The higher the compression ratio, the less was the consumption per brake-horsepower-hour, and the greater was the thermal efficiency at all loads with all the alcohol fuels. The most economical consumptions using alcohol were 1.10 pounds per brake-horsepower-hour at compression ratio 4.28; 1.06 pounds per brake-horsepower-hour at compression ratio 5.03; and 0.91 pound per brake-horsepower-hour at compression ratio 6.43.

The maximum power that was developed by the engine increased as the compression ratio was increased. No satisfactory tests could be run with kerosene at a compression ratio of 5.03. There seemed to be no appreciable effect on the consumption of fuel per brake-horsepower when the compression ratio was changed from 4.28 to 5.03, using gasoline. However, in this case, the maximum power delivered seemed to increase slightly.

Except for some slight hammering of the engine, when a very lean mixture was used, the higher the compression ratio, the smoother and the quieter the engine ran, using alcohol. No evidence of overheating, preignition, knocking or corrosion was observed with changes of compression ratio.

In general, the lower the percentage of water in alcohol fuels, the less was the consumption per brake-horsepower-hour. The engine was more noiseless as the per cent of alcohol present in the fuel was greater. Due to the presence of water in the fuel, greater efficiency was developed near or beyond the normal load than at any other point below it.

With undiluted denatured alcohol and ethyl alcohol, starting at an engine temperature of below 70 F. was almost impossible, for a compression ratio of 4.28. At a compression ratio of 5.03, the engine started at 70 but responded more quickly at about 75. Easy starting was made on 94.3 per cent ethyl alcohol at a temperature below 60 when the compression ratio was 6.43.

The author believes that from the showing of the tractor during the tests made on gasoline and on kerosene, some provisions should be made to inject water into the cylinder with the fuel for loads varying from three-quarters to normal. The high temperature of the induction pipe diminished the volumetric efficiency at these loads. In the case of alcohol, how-

ever, better results were obtained at these loads. The latent heat of vaporization of the fuel was high so that the high temperature of the intake manifold was not an objection but rather an advantage.

Effect of Use on the Properties of Motor Oils, S. L. Smith and E. Giaister (Engineer [London], 151 (1931), No. 3929, pp. 476-478, figs. 10).—Experiments with the Deeley oil-testing machine are reported which were conducted at the City and Guilds College, South Kensington, England.

Both the static and kinetic coefficients of friction were measured and these utilized to find the changes brought about in the lubricating properties of certain motor oils when used in internal-combustion engines. The machine consists of two opposing friction surfaces, the lower a cast-iron disk and the upper made up of three mild steel pegs 5/32 inch in diameter disposed symmetrically in a circle 7 centimeters in diameter. A torque measuring device is attached which consists of a coil spring and indicating mechanism. A tray carrying the disk can be rotated, and, by friction, the pegs tend to rotate the upper element. The lubricant to be tested is used to cover the surface of the disk, and observations are made of the torque transmission under given conditions of speed and load. The static coefficient is obtained if the disk is rotated against the resistance of the spring until slipping just occurs between the pegs and the disk. If the disk is rotated at a predetermined constant speed providing a steady slip between the surfaces, the machine reading gives the kinetic coefficient of friction. The most significant result from the experiments showed that there is a large decrease in the kinetic coefficient of motor oils during use, due entirely to the reduction in viscosity brought about by fuel dilution.

The results also showed conclusively that the Deeley machine can be used successfully to measure the kinetic coefficient of a lubricant when in the truly fluid or the semifluid state.

The Combine Harvester in Western Canada, E. A. Hardy (Science Agriculture (Ottawa, Can.) 12 (1931), No. 3, pp. 121-129, figs. 5).—In a contribution from the University of Saskatchewan, an account is given of experience in the use of the combine and related machinery in western Canada.

Run-Off Investigations in Central Illinois, G. W. Pickels (Illinois University, Engineering Experiment Station (Urbana) Bulletin 232 (1931), pp. 134, figs. 38).—Studies conducted by the station in cooperation with the U.S.D.A. Bureau of Public Roads are reported, the purpose of which was to determine (1) the roughness factor **n** in Kutter's formula for flow of water in open drainage channels in central Illinois, (2) the maximum discharge for which drainage channels in central Illinois should be designed, and (3) the annual yields of small watersheds, such as are found in central Illinois.

It was found that the minimum value of **n** which should be used in the design of drainage ditches in central Illinois is 0.040. This value obtains at high stages during the summer months in the best-maintained channels where the bottom of the channel is clear of vegetation and the side slopes are covered with grass or low weeds, but no bushes. This low value of **n** should not be used unless the channel is to be cleared annually of all weeds and bushes.

A value of **n** of 0.050 should be used if the channel is to be cleared in alternate years only. Large weeds and bushy willows 3 to 4 feet high on the side slopes will produce this value of **n**. In channels which are not cleared for a number of years the growth may become so abundant that values of **n** above 0.100 may exist. Trees 6 to 8 inches in diameter growing on the side slopes do not impede the flow so much as do small bushy growths, provided the lower, overhanging limbs are cut off.

The size of watershed did not seem to be as important for small watersheds as has generally been considered. Topography has a marked effect upon the rates of flood run-off, even from watersheds which are so flat as to require artificial drainage for successful agriculture. Completeness of drainage is an important characteristic. The more adequate the drainage facilities the greater the rate of flood discharge during excessive storm periods, especially those occurring during the winter and spring. Drainage ditches in central Illinois should be designed to carry maximum discharges of from 15 to 30 sec.-feet per square mile of watershed area, depending upon the topography, completeness of drainage and the degree of protection desired. It is believed that the higher value will not be exceeded on the average more often than once in 25 years.

It would appear, from watersheds similar to those studied, that the annual yield during the normal year should be from 9 to 11 inches, that on an average of once in 10 years a yield as low as 7 inches may be expected, and that on an average of once in 20 years an annual yield as low as 6 inches may occur.

Utilization of Anthracite for Domestic Heating, A. J. Johnson (Heating, Piping and Air Conditioning (New York) 3 (1931), No. 12, pp. 1050-1054, figs. 12).—In a contribution from the Anthracite Institute Laboratory the experimental apparatus used in domestic heating studies is described and information given on the selection of sizes of anthracite for different purposes and the selection, installation and operation of mechanical draft units, automatic anthracite stokers and magazine feed boilers.

It has been found that the practical firing interval for a given fuel is directly proportional to the rate of combustion and very closely linked to the uniformity of burning. With anthracite the overall efficiency of the furnace is not materially affected by changes in the stack draft available.

Data are given on proper ash pit pressures for various combustion rates and coal sizes when using mechanical blowers. It is desirable to so locate the blower that the greatest volume of air will pass through the fuel bed at a point farthest from the uptake of the furnace.

It is recommended also that a bright spot be kept in the fuel bed for the ignition of gas whenever mechanical draft is employed.

Mechanical Laboratory Methods, J. C. Smallwood and F. W. Keator (New York: D. Van Nostrand Co., 1931, 4. ed., pp. XII + 386, figs. 121).—This is the fourth revised edition of this book relating to laboratory methods and equipment for experimental work in mechanical engineering. Much of the information presented is directly applicable to experimental work in agricultural engineering.

Part 1 deals with the testing of experimental instruments and apparatus and contains chapters on weights and forces; pressure; thermometry; heat of steam, calorimetry and sampling; angular velocity; time; irregular areas and mean heights; power; the engine indicator and reducing motions; and fluid meters.

Part 2 deals with the analysis of combustion and contains chapters on the constituents of fuels; the heat value of fuels; products of combustion; theoretical reactions of fuels; calculations from exhaust gas analyses; and specific heats, energy and enthalpy of gases.

Part 3 deals among other things with the testing of prime movers, steam boilers and refrigerating machinery.

Part 4 deals with tests of miscellaneous equipment such as hydraulic rams, hoists and belt testers, and with hygrometry, lubricating oils and electrical machinery.

Appendixes are included on logarithms of numbers, diameters and areas of circles, weight of water, steam tables, and properties of ammonia; American Society of Mechanical Engineers' code on definitions and values; and preparation of reports of engineering tests.

The Combined Harvester-Thresher in Ohio, E. A. Silver and J. H. Sitterley (Ohio Station (Wooster) Bulletin 491 (1931), pp. 50, figs. 17).—This bulletin consists of two parts.

Part 1, by Sitterley, deals with economic considerations and gives information on the adaptability of the combined harvester-thresher to Ohio conditions. The advantages are enumerated as (1) lowers harvesting costs, (2) reduces harvest labor, (3) reduces length of harvest season, (4) creates independence of exchange labor, (5) improves the picking up of down grain, (6) spreads the straw, and (7) reduces the cost and number of harvest meals. The disadvantages are the large investment, the loss of straw, and the difficulty in handling green material.

Part 2, by Silver, relates entirely to engineering matters and gives both technical and practical information on combine construction, power requirements, care and operation of combines and combining under different conditions, the prevention of grain losses by different methods, grain drying, soybean harvesting, and the handling of straw.

Feed Grinder Investigations, E. A. Silver (Ohio Station (Wooster) Bulletin 490 (1931), pp. 49, figs. 36).—This bulletin presents practical and technical information on the operation and care of feed grinders and reports data from tests of feed mill efficiency, the effect of size of screens on fineness of grinding, and on the uniformity of size of ground particles.

The data on the effect of moisture content of grain on power requirements show that nearly twice as much feed containing 10 per cent moisture can be ground per horsepower-hour as feed containing 25 per cent moisture. It appears that moisture in the grain has a greater effect in increasing the power requirements for grinding than moisture in the cob.

The burr mill was found to be very satisfactory for grinding shelled corn or other grains having a high, dry starch content to a medium or coarse size. The hammer mill gave superior results for fine grinding of these feeds and for oats grinding. It also is found that slower speeds of hammer mills produce a coarser product and higher speeds a finer product. However, if the speed is reduced much below its rated revolutions per minute the fan may be unable to elevate the material, especially when grinding oats.

Economical Use of Large Tile for Land Drainage, R. D. Marsden (U. S. Department of Agriculture, Technical Bulletin 269 (1931), pp. 24, figs. 6).—The results of a critical survey of drainage records in 31 counties in Minnesota, Iowa, Wisconsin, Illinois, Indiana, Michigan and Ohio are presented, the purpose being to study the economy of using large draintile.

It was found that tile of large diameter have been used for draining land in many instances where open ditches would have provided drainage for less cost. The annual expenditures for maintenance of tile drains by 106 drainage districts, representative of general conditions in the upper Mississippi Valley, averaged about two-thirds of one per cent of the cost of the tile and the labor of installation. The average annual cost of keeping open ditches in fairly effective condition in the same region is indicated to be about 5 per cent of the cost of excavation and damages. On the basis of average prices paid for drainage construction during 1922 to 1925 and annual maintenance expenditures capitalized at 6.75 per cent per year, it appears that tile drainage and open ditches may be equal in ulti-

mate cost when the purchase of tile and trenching, laying and back filling will be from 70 to 100 per cent greater than the cost of excavation and damages for the open ditch.

Graphs and formulas are presented for reducing the labor of making such comparisons.

Bibliography Relating to Farm Structures, G. Ervin (U. S. Department of Agriculture, Miscellaneous Publications 125 (1931), pp. 43).—A bibliography relating to farm structures is presented which contains material classified according to subjects. No references are included relating to equipment such as heating, lighting, ventilation and refrigeration.

Results of Experiments on Earth Pressures [trans. title], L. Ravier (Compt. Rend. Academy of Science [Paris], 190 (1930), No. 8, pp. 470-472; abs. in [Great Britain] Department of Science and Industrial Research (London) Building Science Abstracts, n. ser., 3 (1930), No. 4, p. 139).—The results of tests on small-scale retaining walls supporting noncohesive gravel filling showed that the tension in anchor rods due to superloads increases less rapidly than the load and remains practically undiminished when the superload is removed. This is attributed to the fact that the gravel, once compacted by the weight of the superload, does not on removal of the latter regain its former looseness.

The author concludes that if the filling can be compressed without subjecting the wall to increased pressure any addition of superload will result in reduced or negative pressure on the wall. Many gravels are composed of flat particles, which, when disturbed, have a tendency to settle with their flat sides horizontal, and trenches may be cut to a considerable depth in soils which have been compacted under natural conditions, and to a certain point loads may be supported near the edges without causing them to fall in. Such considerations detract from the value of theories of earth pressures based on the assumption that the soil is an isotropic medium.

Coulomb's theory is considered the best, as it is most easily adapted to actual conditions.

Acid Resisting Metals: A few comparative tests, J. W. McMyn and V. Edge (Jour. Soc. Chem. Indus., Chemistry and Industry (London) 50 (1931), No. 23, p. 474).—In a contribution from the Royal Technical College of England tabular data are presented indicating the effect of various solutions on three so-called acid-resisting metals when compared at different concentrations and temperatures and for different periods of time. The tests were conducted on small strips of the metals 3 by ½ by ⅛ in, each immersed in approximately 60 cc of the solution in a wide test tube. Cold tests were conducted at room temperature and hot tests in a large water bath heated to 80 deg (C).

One of the metals was a steel containing a considerable amount of chromium. The second consisted chiefly of nickel and copper, and the third of copper with some aluminum and nickel. The last alloy showed the least corrosion in the majority of cases. The chromium steel in cold 30 per cent sulfuric acid lost considerably in weight in the first 24 hours and still more in a week. Using fresh acid during the second week there was much less loss in weight, and no further attack occurred by a third supply of fresh acid during the next three weeks. Evidently after the first attack a passive surface is obtained which is quite resistant to further attack by cold 30 per cent sulfuric acid. It also was found to resist attack even up to a temperature of 60 deg.

Daily River Stages at River Gage Stations on the Principal Rivers of the United States, compiled by M. W. Hayes (U. S. Department of Agriculture, Weather Bureau, Daily River Stages, 28 (1930), pp. III + 156).—This volume contains the daily river stages for 1930 and is the tweny-eighth of a series of daily river stages on the principal rivers of the United States.

Electrical Equipment on Movable Bridges, C. B. McCullough, A. L. Gemeny, and W. R. Wickerham (U. S. Department of Agriculture, Technical Bulletin 265 (1931), pp. 114, figs. 70). — This is a condensed presentation of those fundamental principles of movable bridge electrification which must be applied in making a selection of an assembly of electrical apparatus for bridges. It contains main sections on electric motors, control and interlocking of operations, wiring for electric control, and recent developments in electrical bridge control.

An appendix contains extracts from the Industrial Control Standards of the National Electrical Manufacturers' Association relating to definitions, kinds of protection, relays, qualifying terms of relays, properties and characteristics of apparatus, rating, performance and test, and manufacturers' specifications.

Charts Show Fundamentals of the Drying Process, M. Tomlinson (Heating, Piping and Air Conditioning (Chicago) 3 (1931), No. 12, pp.1017-1020, figs. 8).—Graphic data are presented showing the effect of a change in any one of the factors which influence the drying process. Control instruments also are discussed. These data are generally applicable among other things to the artificial dehydration of agricultural products and may be used to develop methods for the solution of specific drying problems.

Elimination of Taste in Water Passing Through Creosoted Wood Stave Pipe, J. F. Harkom and C. Greaves (Engineering Journal (Montreal), 14 (1931), No. 10, pp. 515-517, figs. 3).—In a contribution from the Forest Products Laboratories of Canada the results of an investigation are presented as to the probable outcome of passing potable water through a very long pipe line of creosoted wood stave construction. These show that filtration tests should be continued to determine the cost of using activated carbon, since there does not appear to be any prospect of obtaining satisfactory taste removal by superchlorination followed by dechlorination.

Care and Use of Explosives, E. Godfrey (Engineering Journal (Montreal) 14 (1931), No. 10, pp. 521-523).—The author treats briefly the precautions necessary in the use of explosives for various industrial purposes and the requirements for their safe storage. Methods of drilling and spacing holes are discussed, together with the type of explosives required for different purposes, including stump, bowlder, and ditch blasting.

The Combine Harvester-Thresher, H. J. Hopfen ([International Review of Agriculture], Monthly Bulletin of Agricultural Science and Practice [Rome], 22 (1931), No. 9, pp. 344-353). — A brief critical summary is given of experience with the combine in different agricultural regions of the world. It is pointed out that its use is more advantageous in arid regions than in humid regions and favors collective farming. A bibliography of 40 references is included.

New Methods of Testing Fertilizer Distributors, F. Keeble (Journal of Ministry of Agriculture [London, Great Britain], 37 (1930), No. 5, pp. 439-451, pls. 4, fig. 1).—Methods of testing fertilizer distributors are described from the English viewpoint, and trials conducted with four different types of fertilizer are reported. The factors considered in the trials were evenness of distribution, laterally and longitudinally; material, durability, and workmanship; ease of dismantling and cleaning; accuracy of calibration; ease of adjustment; and lightness of draft.

The data obtained are discussed in considerable detail. The results in general indicate the desirability of incorporating in the design of fertilizer distributors lightness combined with strength and a positive measure for the feed. The discharge of the fertilizer should be close to the ground, and parts working in the fertilizer should be avoided. Better lubrication of moving parts should be incorporated, and a good quality of protective covering is required on the metal construction.

The Problem of Soil Saving in the Hawaiian Islands, T. C. Zschokke (Hawaii University, Honolulu Agricultural Extension Bulletin 11 (1931), pp. 25, figs. 8).—This bulletin deals with erosion losses in the Hawaiian Islands and considers methods for preventing erosion of agricultural land. The methods recommended for saving top soil include better tillage, the use of cover and green manure crops, the installation of broad-base terraces, and the laying out of plant rows and ditches in a manner such as to handle surface run-off more effectively. Erosion of pasture lands has been prevented by planting grasses, forage plants, shrubs, and trees.

Surface Water Supply of the United States, 1929, I, IV, VII, IX (U. S. Geological Survey, Water-Supply Papers 681 (1931), pp. VIII + 253, fig. 1; 684 (1931), pp. V + 123, fig. 1; 687 (1931), pp. IV + 88, fig. 1; 689 (1931), pp. V + 105, fig. 1).—Of the papers which here present the results of measurements of flow made on streams during the year ended September 30, 1929, No. 681, prepared in cooperation with the States of Maine, New Hampshire, Massachusetts, Connecticut, Vermont, New York, New Jersey, Maryland, and Virginia, covers the north Atlantic slope drainage basins; No. 684, prepared in cooperation with the States of Wisconsin, Illinois, Ohio, New York, and Vermont, the St. Lawrence River Basin; No. 687, prepared in cooperation with the States of Missouri, Arkansas, Kansas, and Texas, the lower Mississippi River Basin; No. 689, prepared in cooperation with the States of Colorado, Utah, Arizona, and Wyoming, the Colorado River Basin.

Pumping Machines and Their Motors [trans. title], A. Blanc Annales de l' Ecole Nationale d 'Agriculture de Montpellier, (Montpellier, France) n. ser., 21 [1931], No. 1, pp. 36-52).—This is technical analysis of pumps for the elevation of subterranean water for irrigation and of the adaptation of animal, wind, and mechanical motive power.

1931 Supplement to Book of A.S.T.M. Standards (Philadelphia: American Society of Testing Materials, 1931, pp. 144, figs. 15).—This pamphlet comprises the first Supplement to the 1930 Book of A.S.T.M. Standards and contains 32 standards adopted or revised on September 1, 1931.

Public Roads, [October, 1931] (U. S. Department of Agriculture, Public Roads, 12 (1931), No. 8, pp. 197-216 + [2], figs. 16). —This number of this periodical deals with the current status of Federal-aid road construction as of September 30, 1931, and contains the following articles: Procedures for Testing Soils for the Determination of the Subgrade Soil Constants, by A. M. Wintermyer, E. A. Willis, and R. C. Thoreen (pp. 197-207); Graphical Solution of the Data Furnished by the Hydrometer Method of Analysis, by E. A. Willis, F. A. Robeson, and C. M. Johnston (pp. 208-215); Investigation of Tar Roads in Progress (p. 216): and Traffic Survey of Washington, D. C., Area Begun (p. 216).

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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Raymond Olney, Editor

R. A. Palmer, Associate Editor

Engineers and Their Professional Societies

INDIVIDUAL engineers have been known to be too active in their professional organizations for their own good, but "To every engineer who goes to excessive lengths in association work there are perhaps thousands who do not go far enough," That is the observation of Mr. L. E. Jermy, editor of "Machine Design."[1]

From his perspective as an engineering editor, interested but without personal bias as either a practicing engineer or a society official, he has presented a frank statement of the personal traits and circumstances which lead to activity below and above the individual optimum, and the considerations which determine that optimum.

Underactivity seems to be due largely to such negative personal traits as lack of ambition, lack of professional pride, selfishness, bitterness, shyness, and lack of sociability. There is also a possibility of it being due in some cases to an unfavorable attitude on the part of employers.

Assumption of professional society committee and official obligations of a nature and to an extent which unfit the individual for his regular work or do not leave time and energy for it, may be equally detrimental to the individual and, in the long run, prevent him from making his greatest possible contribution to his profession. It is an expression of personal traits strongly opposed to those responsible for inactivity.

Either of these extremes, however, may be avoided or escaped by the engineer who obeys the ancient Greek injunction "Know thyself." He can base his professional organization activities on his abilities, the character of his work, the attitude of his employers, his financial condition, and opportunities for constructive work. His decisions may well be guided by the observation previously quoted: "To every engineer who goes to excessive lengths in association work, there are perhaps thousands who do not go far enough."

[1]"How Much Should Engineers Engage in Society Activities," by L. E. Jermy. "Machine Design," May 1932, p. 35.

The Society Officials' Viewpoint

SUPPLEMENTING his own comments, Editor Jermy has presented anonymously the viewpoint of a group of Society officials on "How the Technical Society Regards the Engineer."

The officials recognize in engineers as a group two problems, (1) the low percentage who become members of any professional society, and (2) the low percentage of members who take an active part in the work of their society.

They substantiate Editor Jermy as to the inertia, shortsightedness, selfishness, parasitism, complacency and lack of professional interest of the non-member and inactive groups. They seem slightly irked at the indifference of a large proportion of men with engineering training to such obvious facts as that (1) by interesting themselves only in a limited field of activity they are missing opportunities to increase in usefulness to their employers, their profession, and themselves; (2) to keep interested and informed in more than one narrow phase of their profession they must at least read its current technical literature; (3) membership is easily worth more than its cost to any engineer for the information it gives him, in technical literature and meetings, which will prevent losses of time and money, and make possible positive financial gains; and (4) their professional society is organized and maintained by their profession for what it is worth to them as a group and can continue to exist only as long as it is well worth its cost to its members.

But the society officials are not discouraged by unqualified percentage comparisons and low apparent effectiveness of their organizations. They have good reason to be optimistic; to look forward to increasingly representative membership and higher active-member ratios. Be it cause or effect of their membership and activity, the present nuclei of active society members are "alert engineers who know by experience that mutual exchange of data with their fellows will bring them the accumulated knowledge and experience of their profession as a whole. They also are motivated somewhat by the spirit of service and pride in profession, which are priceless assets." Organizations with active leaders of this type will live on with the surviving fittest, continually attracting and developing new members of similar character.

Professional Meeting Values

SOME employers still question the value to them of sending their engineers to the meetings of professional engineering societies. A few are definitely opposed to the idea. Others regard the practice as a sort of business luxury, easily dispensed with in any retrenchment program.

Can such attendance be urged as necessary and justifiable from the standpoint of tangible values? We believe it can. However, we do not ask anyone to take our word for it. Engineering practice requires the preparation of many reports. Why not make an accounting of the benefits of attending meetings as well as of the expenses?

We suggest that each engineer attending the A.S.A.E. annual meeting this month make a note each night of the number, nature, and probable value to him of ideas and understanding gained during the day; likewise the contacts made, the opportunities met, the recognition gained. The individual's summary of these benefits for the whole meeting will be enlightening to himself and to his superiors.

In a program of permanent retrenchment, liquidation, and recession from business, the benefits of meeting attendance would be negligible and easily dispensed with, but for engineers and their employers who hope to stay in the game or "stage a comeback," these benefits must be obtained somehow, sometime, at some expense. Can any agricultural engineer obtain them for himself and his organization more economically than in the intensive concentration of agricultural engineering personalities, interests, educational activity and inspirational influence which is the A.S.A.E. annual meeting?

A.S.A.E. and Related Activities

The A.S.A.E. Annual Meeting

GIVEN a time; a place; a conception of the annual meeting needs of the American Society of Agricultural Engineers; a national economic situation; and a national field of problems, progress and personalities to work with, the A.S.A.E. Meetings Committee has analyzed, selected, designed, and assembled a multitude of details into complete, coordinated, operable annual meeting arrangements.

As the time for their operation approaches, the Committee is giving the final polish and adjustments to a few minor details; making every possible advance preparation for the personal comfort, entertainment, and professional enrichment of all who will be present.

"Regulars," "occasionals" and "first timers" at A.S.A.E. annual meetings, many with their wives and families, will begin arriving in Columbus the middle of the week before the meeting for the College Division's pre-meeting conferences on agricultural engineering extension and research. The influx will probably reach its peak Sunday, June 19, and be practically completed by Tuesday morning.

Ives Hall, the agricultural engineering building on Neil Avenue at the north side of the Ohio State University campus, will be the official headquarters and center of activity of the meeting. All of the regular sessions will be held there except the annual banquet, which will be served at the Deshler-Wallick Hotel downtown. A downtown headquarters and information bureau will be maintained in that hotel during the meeting.

Accommodations available include Neil Hall, the University's newest and largest dormitory (at reasonable rates); downtown hotels, less than three miles from the campus; camping facilities near or under the Ohio Stadium, which is close to Ives Hall; and a wide variety of eating places, including the University restaurants and cafeterias. Many group luncheons will probably be held at the Faculty Club, on the campus.

Excellent golf and swimming facilities have been provided for the men who may find time for these sports; card parties, trips, luncheons, swimming, and golfing have all been planned for the visiting ladies and children by the wives of the Columbus members.

The Extension Conference will occupy three full days, June 16, 17, and 18 and the Research Conference, the latter two of those days. Monday morning, June 20, the college men will meet again in a College Division session, the opening session of the annual meeting. There will be continued emphasis on extension and research. Following the start made last year, college and commercial extension workers will hold a dinner session together.

Increased emphasis has been given to the student members' session this year. It is scheduled for Monday evening, with a student chairman presiding, and an ambitious program including reports from the student branches represented; a technical paper; addresses by C. E. Seitz, chairman of the College Division and president-elect of the Society, and Leonard J. Fletcher, president of the Society; and general discussion.

In the general sessions Tuesday, Wednesday, and Thursday more attention will be given than previously to what President Fletcher calls "higher values"—the economic and social significance of engineering developments and the engineering opportunities and obligations of economic and social situations. The quality of thought being directed to this phase of the sessions and their constructive possibilities, are suggested by such names on the program as J. T. Jardine, C. F. Kettering, M. L. Wilson, Arthur Huntington and Leonard J. Fletcher. Others will supplement their contributions with discussion from the floor.

Place in the general sessions has also been given to a few of the many technical agricultural-engineering developments which are of interest to all agricultural engineers. These include artificial drying, fertilizer application, soil erosion, and a specific example of a planned engineered agriculture.

Tuesday, Wednesday and Thursday afternoons have been split into two periods of one hour and forty-five minutes each, during which two technical sessions will be carried on simultaneously. Some of these will be joint sessions of two divisions to which the technology under discussion is of mutual interest. By this arrangement each technical division has been able to schedule at least two independent sessions and to participate in one or more joint sessions.

As in recent years the annual business meeting, on Tuesday evening, will be freed of routine reports, as far as possible, and the time used in discussion of immediate, active matters warranting consideration by the Society as a whole.

President Fletcher, in charge of the principal feature of the meeting, the annual banquet, has promised a short, lively affair with just the right kind of music; Daniel Seltzer as toastmaster; an illustrated address on Russia by E. J. Stirniman, recently returned from that country; and plenty of time following adjournment for dancing, visiting, or committee meetings.

The division chairmen have warned their members not to plan on leaving before their closing sessions which will be as important and valuable as any others during the meeting.

Conference of Extension Agricultural Engineers

Ohio State University, Columbus, Ohio
June 16, 17, 18, 1932

Thursday—June 16

Forenoon—10:00 to 12:00

George Amundson, chairman of conference, presiding

1. Some Objectives in Extension Teaching —H. C. Ramsower, director, Extension Service, Ohio State University
2. Why Do We Act?—A. B. Graham, in charge subject-matter specialists, Office of Cooperative Extension Work, U.S.D.A.

Afternoon—2:00 to 5:00

1. Measuring Extension Accomplishment —M. C. Wilson, in charge extension studies and teaching, Office of Cooperative Extension Work, U.S.D.A.
2. Our Annual Plans of Work — I. D. Wood, extension agricultural engineer, University of Nebraska

Evening—7:00 to 9:00

1. SYMPOSIUM: Power and Machinery Extension Work
   (a) W. H. McPheters, extension agricultural engineer, Connecticut Agricultural College
   (b) H. W. Hochbaum, field agent, Eastern States Office of Cooperative Extension Work
   (c) R. D. Barden, extension agricultural engineer, Ohio State University, and W. L. Bluck, agricultural agent, Clinton County, Ohio

Friday—June 17

Forenoon—9:00 to 12:00

1. SYMPOSIUM: Structures Extension Work
   (a) H. P. Twitchell, extension agricultural engineer, Ohio State University
   (b) E. G. Johnson, extension agricultural engineer, University of Illinois
   (c) J. P. Fairbank, extension agricultural engineer, University of California
   (d) I. D. Wood, extension agricultural engineer, University of Nebraska
2. The President's Conference on Home Building and Home Ownership — Wallace Ashby, chief, division of structures, Bureau of Agricultural Engineering, U.S.D.A.
3. The Correlation of Home Improvement Extension Work—Miss Thelma Beall, home management specialist, University of Ohio

Afternoon—2:00 to 5:00

1. SYMPOSIUM: Rural Electrification Extension Work
   (a) H. G. Gallagher, research and extension engineer, Michigan State College
   (b) George W. Kable, director of research, Committee on the Relation of Electricity to Agriculture
   (c) W. C. Krueger, extension agricultural engineer, Rutgers University

(d) R. R. Parks, research and extension engineer, University of Missouri

2. SYMPOSIUM: Four-H Club Work
   (a) H. S. Pringle, extension agricultural engineer, Cornell University
   (b) Paul R. Hoff, extension agricultural engineer, University of Nebraska
   (c) C. V. Phagan, extension agricultural engineer, Oklahoma A. & M. College

Discussion by roll call of states represented.

Evening—7:00 to 9:00

RESEARCH AND EXTENSION CONFERENCE—JOINT SESSION

Virgil Overholt, presiding

1. A Situation Survey in Illinois—E. W. Lehmann, professor of agricultural engineering, University of Illinois
2. The Selection and Development of Extension Recommendations, B. B. Robb, professor of agricultural engineering, Cornell University
3. Coordinating Research and Extension —Leonard J. Fletcher, president, American Society of Agricultural Engineers, and J. B. Davidson, professor of agricultural engineering, Iowa State College

Saturday—June 18

Forenoon—9:00 to 12:00

1. SYMPOSIUM: Field Improvement Extension Work
   (a) E. G. Welch, extension agricultural engineer, University of Kentucky
   (b) L. A. Jones, chief, division of drainage and soil erosion control, Bureau of Agricultural Engineering, U. S. Department of Agriculture
   (c) M. R. Bentley, extension agricultural engineer, A. & M. College of Texas
   (d) J. B. Wilson, extension agricultural engineer, Alabama Polytechnic Institute
   (e) J. S. Glass, extension agricultural engineer, Kansas State College
   (f) J. W. Carpenter, Jr., extension agricultural engineer, Oklahoma A. & M. College
   (g) H. W. Hochbaum, field agent, Eastern States Office of Cooperative Extension Work, U.S.D.A.

Conference of Research Agricultural Engineers (Tentative Program)

Ohio State University, Columbus, Ohio June 17 and 18, 1932

Friday, June 17

Forenoon—9:00 to 12:00

1. SYMPOSIUM: What Is Research, Near Research and Not Research?—H. A. Arnold, R. U. Blasingame, H. B. Dinneen, R. B. Gray, V. R. Hillman, M.M. Jones, E. C. Sauve, J. P Schaenzer, C. E. Seitz, and A. L. Young

Afternoon—2:00 to 5:00

1. SYMPOSIUM: How to Research — Wallace Ashby, F. W. Duffee, H. L. Garver, A. W. Lavers, E. B. Lewis, S. H. McCrory, M. L. Nichols, R. R. Parks, O. E. Robey, D. E. Wiant, and F. J. Zink

Evening—7:00 to 9:00

(Joint session, see program for Conference of Extension Agricultural Engineers)

Saturday, June 18

Forenoon—9:00 to 12:00

1. SYMPOSIUM: How to Research (continued) — Roy Bainer, R. H. Driftmier, C. I. Gunness, L. A. Jones, H. H. Musselman, F. E. Price, C. E. Ramser, H. W. Riley, R. H. Reed, John P. Seaholm, and J. W. Sjogren

Afternoon—2:00 to 5:00

1. SYMPOSIUM: Research Reports — Technical, Popular, Bulletins and Publicity — R. W. Carpenter, F. C. Fenton, Henry Giese, W. J. Gilmore, E. W. Lehmann, W. W. McLaughlin, R. M. Merrill, Dent Parrett, P. B. Potter, C. O. Reed, and D. D. Smith
2. Summary and Criticism

President Fletcher's Speaking Engagements

LEONARD J. FLETCHER, president of A.S.A.E. has been travelling a great deal during April and May, and will be during June up to the time of the Society's annual meeting. Incidentally he has accepted invitations to speak on agricultural engineering to a number of groups.

For June, up to the time of the annual meeting, his speaking engagements include the Student Branch of A.S.A.E. at Iowa State College, June 2; the Agricultural Bureau of the Winnipeg (Canada) Board of Trade, June 13; and the Canadian Society of Technical Agriculturists, June 16. He should be in good training for his addresses and presiding duties by the time he reaches Columbus.

Structures Research Report Available

HENRY GIESE'S final report as director of the U.S.D.A. Survey of Research in Farm Structures has recently been made available in printed form as U.S.D.A. Miscellaneous Publication No. 133, entitled "Research in Farm Structures." A.S.A.E. was active in urging that the survey be made and was represented on the Advisory Council which had general charge of the work. The report is for sale by the Superintendent of Documents, Washington, D. C., at 15 cents per copy.

Home Economists to Meet in Atlanta

THE American Home Economics Association will hold its twenty-fifth annual meeting at Atlanta, Georgia, June 20 to 25. Headquarters will be at the Atlanta-Biltmore Hotel.

Central theme of the meeting will be "Revaluations in Home Economics." There will be sessions on housing and household equipment.

Necrology

HARRY H. BARROWS, assistant chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture, died suddenly, May 3, from a heart attack, at his residence, 1402 L Street, N.W., Washington, D. C., and was buried in Arlington National Cemetery, May 6. Mr. Barrows had been a member of the American Society of Agricultural Engineers since 1923.

He joined the bureau in 1910 as assistant office engineer in drainage investigations and in the twenty-two years held the positions of drainage engineer, senior drainage engineer and assistant to the chief. For the past several years he had been one of the key men of the bureau and was engaged in administrative work.

While only a few of the publications of the bureau bear his signature, practically all of them for the past twenty-two years were reviewed by him and much of their accurateness and clearness is due to his careful work.

Mr. Barrows had the personal confidence and sincere respect of each of his co-workers who will cherish the memory of his helpfulness and patience, his pleasant personality, sterling character, energy and ability.

He was born in Kent, Ohio, February 5, 1874, and was educated in the public schools at Cleveland. He attended Iowa State College and Ohio State University, and was graduated from the latter in 1898 with the degree of civil engineer.

From 1898 to 1910 he held various positions, ranging from rodman to division engineer, with the Southern and the Missouri-Pacific Railways.

Mr. Barrows served overseas in the World War as Captain of Engineers, U. S. Army, from September, 1917, to July, 1919.

He is survived by his brother, E. M. Barrows, New York City, and four sisters, Miss Alice Barrows, San Francisco, Miss Sarah T. Barrows, Berkeley, Calif., Miss Frances Barrows, Clovis, Calif., and Mrs. A. B. Chorpenning, Evanston, Illinois.

New ASAE Members

Elmer O. Anderson, Connecticut Agricultural College, Storrs, Conn.

Earl L. Arnold, 214 Thurston Ave., Ithaca, N. Y.

R. Pardow Hooper, 114 Sansome St., San Francisco, Calif.

Herbert J. Rath, 2001 Teel St., Lansing, Mich.

Marvin F. Schweers, Agricultural Engineering Extension, East Lansing, Mich.

John W. Weaver, Jr., Eastern Shore Public Service Co., Salisbury, Md.

G. E. Wenzloff, Lawrence Park West, Bronxville, N. Y.

Laurence M. Whiting, West Concord, Minn.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the May issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Earl Robert Young, farmer, Route 5, Owatonna, Minn.